# SCIENTIFIC AMERICAN REFERENCE BOOK

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FUNNELS AND HOUSE FLAGS OF SOME PRINCIPAL STEAMSHIP LINES IN AMERICAN TRADE.

# Scientific American Reference Book

*Compiled by*
Albert A. Hopkins
and
A. Russell Bond

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1906

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# PREFACE.

THE Editor of the SCIENTIFIC AMERICAN receives during the year thousands of inquiries from readers and correspondents covering a wide range of topics. The information sought for, in many cases, can not readily be found in any available reference or text-book. It has been decided, therefore, to prepare a work which shall be comprehensive in character and which shall contain a mass of information not readily procured elsewhere. The very wide range of topics covered in the SCIENTIFIC AMERICAN REFERENCE BOOK may be inferred by examining the index and table of contents. This work has been made as non-technical as the subjects treated of will admit, and is intended as a ready reference book for the home and the office. It is possible that in some of the tables published in the book certain inconsistencies may be observed. Such a condition of affairs is in some cases inevitable. In procuring the figures, for example, from different Departments of the Government, with reference to any subject, it has been found that statistics vary in certain particulars. These variations are due to the different methods of tabulation, or to some different system by means of which the figures have been arrived at. In a number of cases these discrepancies will be noted in the book, but they are not to be regarded as errors.

The debt for advice and help has been a heavy one. The compilation of this book would have been impossible without the cordial cooperation of government officials, who have been most kind. Our thanks are especially due to the Hon. O. P. Austin, Chief of the Bureau of Statistics, Department of Commerce and Labor; to the Hon. S. N. D. North, Director of the Census; Prof. John C. Monaghan, Editor of the Consular Reports; Hon. Eugene Tyler Chamberlain, Commissioner Bureau of Navigation; Dr. Marcus Benjamin, of the Smithsonian Institution; Major W. D. Beach, U. S. A., of the General Staff; Rear-Admiral Charles O'Neil, late Chief of Bureau of

Ordnance, U. S. N.; Hon. S. I. Kimball, General Superintendent, Life Saving Service; the Director of the Mint, Capt. Seaton Schroeder, U. S. N., Chief Intelligence Officer, U. S. N.; many examiners in the Patent Office; Hon. Willis L. Moore, Chief of the Weather Bureau; many officials of the Agricultural Department; Hon. Carroll D. Wright, Commissioner Bureau of Labor; Hon. George M. Bowers, and Mr. A. B. Alexander, of the Bureau of Fisheries; Prof. Charles Baskerville, Ph.D.; Edward W. Byrn, of Washington; Dr. George F. Kunz, Hon. S. W. Stratton, of the Bureau of Standards. For much of the matter relating to naval and military subjects, and for the article on Radium, we are indebted to the Scientific American staff.

We are also indebted to the J. B. Lippincott Co. for permission to use diagrams of Geometrical Constructions; to Hazell's Annual, Whitaker's Almanack, and the "Daily Mail Year Book." A number of our diagrams are from the "Universal-Taschen Atlas" of Prof A. L. Hichmann. Our matter on the "Arctic Regions" is translated from Dr. Hermann Haack's "Geographen-Kalender." For a number of our tables we must thank the excellent pocket books of D. K. Clark and Philip R. Bjorling, and we are also indebted to the Year Book issued by our esteemed English contemporary "Knowledge."

It is hoped that this work will save many fruitless searches through works of reference, as the aim of the compilers has been to obtain matter which is not readily available elsewhere.

NEW YORK, October 15, 1904.

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## PREFACE TO THE SECOND EDITION.

A few corrections have been made and the work thoroughly brought up to date. In many cases the government figures are anticipated. The cordial reception tendered the first edition shows that this work was a necessity.

NEW YORK, October 15, 1905.

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Composition of Battery Cells.
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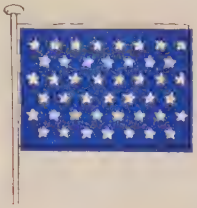
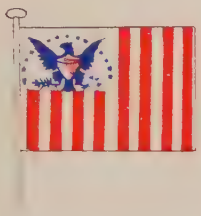
FLAG OF THE PRESIDENT.

U. S FLAG.

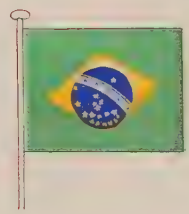


U. S. UNION JACK.



REVENUE FLAG.

BELGIUM.



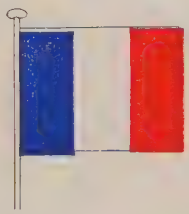
BRAZIL.

CHILE

CRETE.

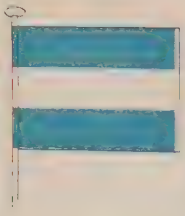
CUBA

ECUADOR.



FRANCE.

AUSTRIA – HUNGARY.

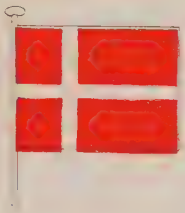


ARGENTINA

CHINA

COLOMBIA

COSTA RICA.



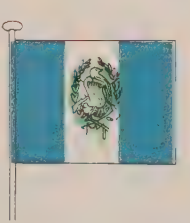
DENMARK

GERMANY

GREAT BRITAIN.

ROYAL NAVAL RESERVE.
(WITH BADGE,
HOME AND COLONIAL GOVERNMENT DEPARTMENTS)

GREECE.



GUATEMALA

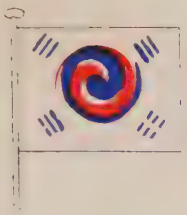
HAITI

HONDURAS

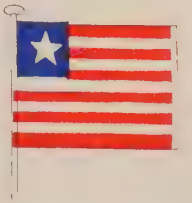
ITALY

JAPAN

KONGO



KOREA



LIBERIA

MOROCCO, MADAGASCAR, MUSCAT

NETHERLANDS

NICARAGUA

IN THE MERCHANT FLAG,
THE BADGE IS NEARER THE MOIST
PARAGUAY.

PORTUGAL.

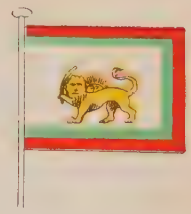
TURKEY, TRIPOLI, EGYPT

URUGUAY.

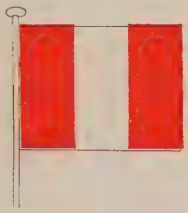
GENEVA CONVENTION

MEXICO

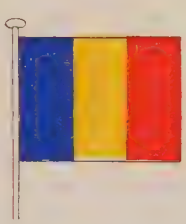
NORWAY



PERSIA.



PERU

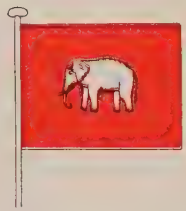


ROUMANIA

RUSSIA

SALVADOR.

SANTO DOMINGO.



SIAM

SPAIN

SWEDEN

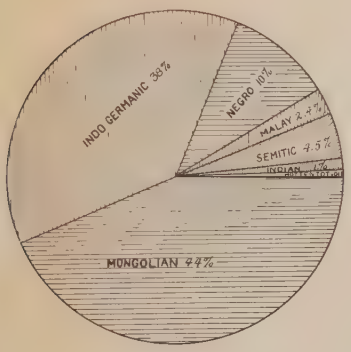
VENEZUELA

# CHAPTER I.

## PROGRESS OF DISCOVERY.

### DIVISIONS INTO RACES.

| Race. | *Location.* | *Number.* |
|---|---|---|
| Indo-Germanic or Aryan | Europe, Persia, India, etc. | 545,500,000 |
| Mongolian or Turanian | Greater Part of Asia | 630,000,000 |
| Semitic or Hamitic | North Africa, Arabia | 65,000,000 |
| Negro and Bantu | Central Africa | 150,000,000 |
| Hottentot and Bushman | South Africa | 150,000 |
| Malay and Polynesian | Australia and Polynesia | 35,000,000 |
| American Indian | North and South America | 15,000,000 |



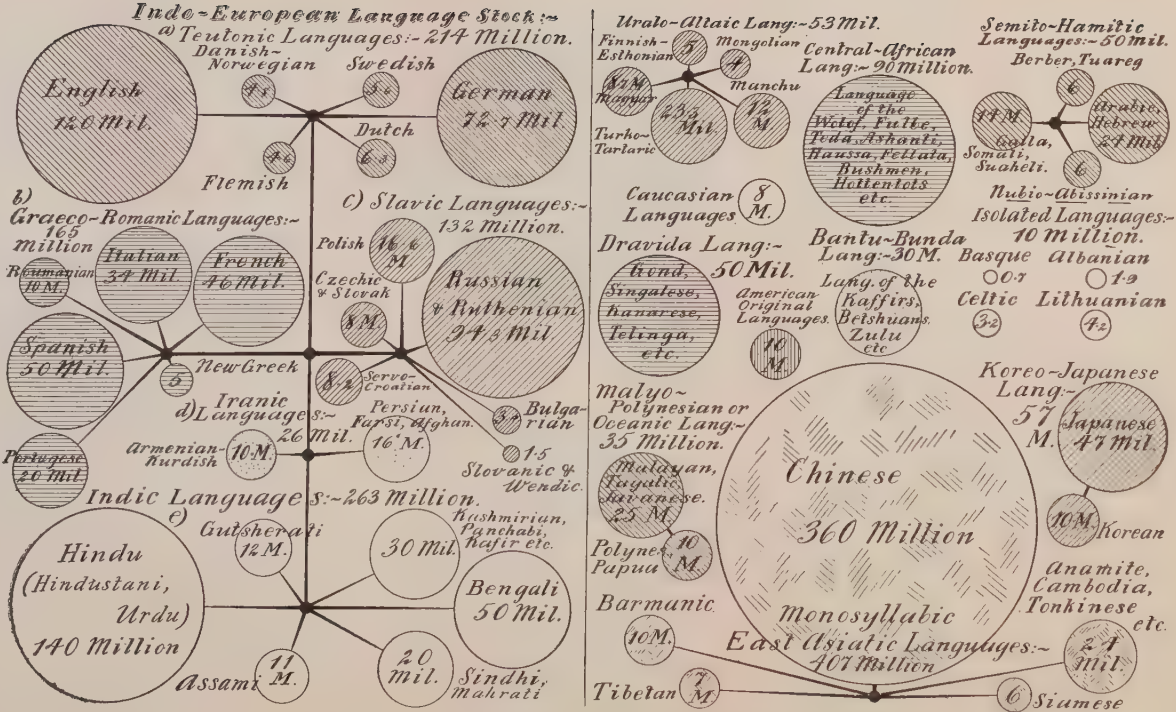

RACES OF MANKIND.

POINTS OF THE COMPASS.

### TOTAL AREAS AND POPULATION OF THE EARTH.

| | *Square Miles.* | *Square Kilometers.* | Population. *In Thousands.* | *Per Square Mile.* | *Per Square Kilo.* |
|---|---|---|---|---|---|
| (1) Asia | 17,071,999 | 44,216,523 | 820,768 | 48.0 | 18.5 |
| (2) Europe | 3,824,956 | 9,906,647 | 393,486 | 102.9 | 40.5 |
| (3) Africa | 11,506,785 | 29,802,603 | 180,321 | 15.6 | 6.2 |
| (4) America | 15,284,872 | 39,587,860 | 146,432 | 9.5 | 3.6 |
| (5) Australia and Oceania | 3,457,667 | 8,955,369 | 6,450 | 1.8 | 0.7 |
| (6) Polar Regions | 1,656,394 | 4,290,065 | 13 | 0.008 | |
| Total | 52,802,673 | 136,759,067 | 1,547,470 | 177.808 | 11.6 |

—*Hübner's Geographisch-Statistische Tabellen.*



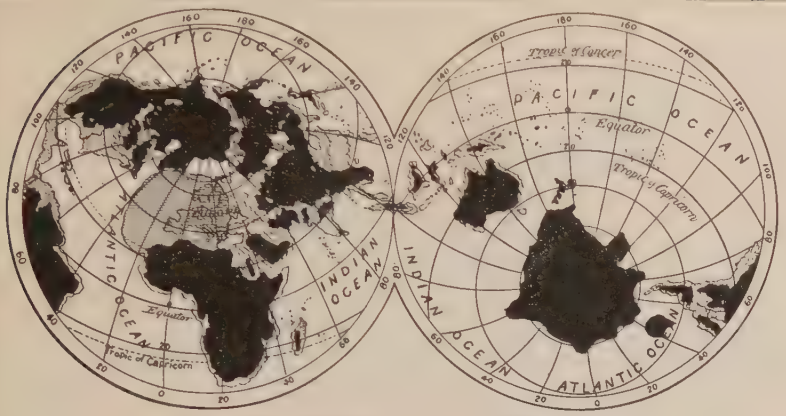

LANGUAGES OF THE WORLD.

## THE PROGRESS OF DISCOVERY.

| Date. | Explorer and Nationality. | Discovery or Exploration. |
|---|---|---|
| B.C. | | |
| 1400–1250 | Egyptians. | Invasions of Habesh, Arabia, Phœnicia, Syria. |
| ? 1350 | Greeks. | Argonautic expedition to Colchis. |
| 1000 | Phœnicians. | Voyages to Ophir, Gades, Britain. |
| 750 | Greeks. | Extension of Colonies in the Mediterranean and Pontus Euxinus. |
| 700 | Samians. | Spain (Tartessus) discovered for the Greeks. |
| 600 | Phœnicians. | Circumnavigation of Africa by order of Necho. |
| 500 | Himilco (Carthag.). | Atlantic coasts of Europe. Sargasso Sea. Said to have visited Britain. |
| " | Anaximander (of Miletus). | Makes the first maps. |
| " | Hecatæus (of Miletus). | Writes the first geography. |
| 470 | Hanno (Carthag.). | West Africa as far as Cape Palmas. |
| 330 | Pytheas of Massilia. | ? Thule, North Sea, Scandinavia. |
| " | Nearchus (Macedon.). | Sails from the Indus to Red Sea. |
| 329–325 | Alexander the Great. | Expedition to Iran, Turan, and India. |
| 290 | Egyptians. | Navigate the East coast of Africa. |
| 218 | Romans. | Hannibal crosses the Alps. |
| about 120 | Eudoxus of Cyzicus. | Attempts circumnavigation of Africa. |
| 61–58 | Romans. | Julius Cæsar in Gaul, Germany, and Britain |
| since 30 | Romans. | Extension of geographical knowledge and commerce as far as Central Asia. |
| 20 | Strabo (Greek). | Describes Roman Empire and first mentions Thule and Ireland. |
| 15 | Romans. | Tiberius discovers the Lake of Constance; Drusus, the Brenner Pass. |
| A.D. | | |
| 84 | Romans. | Agricola circumnavigates Britain. |
| 150 | Claudius Ptolemy (Egypt.) | Constructs his Geography and Atlas. |
| 518–21 | Hoei-sing (Chinese). | Visits Pamirs and Punjab. |
| 671–95 | I-tsing (Chinese). | Visits Java, Sumatra, and India. |
| 861 | Norsemen. | Faroe Islands. North Cape of Europe rounded. |
| 865 | Naddod (Norse). | Discovers Iceland. Visited by Irish monks about 795. |
| 876 | Gunnbjörn (Norse). | Greenland coast. Rediscovered by Erik the Red (983). |
| 985 | Erik the Red (Norse). | Colonizes Greenland. |
| ? 1000 | Lyef Erikson (son of Erik the Red) | Discovers Newfoundland (Helluland), Nova Scotia (Markland), and coast of New England (Vinland)[?]. |
| 1154 | Edrisi (Sicily). | Geographer to King of Sicily, produces his geography. |
| about 1200 | Arabs. | Trading merchants discover Siberia. |
| 1253 | Ruysbroek. | Reaches Karakorum, the ancient seat of the Mongol Empire. |
| 1271–95 | Marco Polo (Venet.). | Travels in Central Asia, China, India, Persia. |
| 1290 | Genoese. | Canaries, Azores, etc. |
| 1325–52 | Ibn Batuta (Arab.). | Travels through the whole Mohammedan World, N. Africa, E. Africa, S. Russia, Arabia, India and China. |
| 1327 | Sir John Mandeville (Eng) | ? Travels in India. |
| 1415–60 | Prince Henry (Port.). | Gives an impetus to Portuguese voyages of discovery. |
| 1419–20 | J. Gonzales and Martin Vaz (Port.). | Porto Santo and Madeira discovered. |
| 1442 | Nuno Tristao (Port.). | Cape Verde, etc. |
| ? 1460 | Cintra and Costa (Port.). | Coast of Guinea reached. |
| 1474 | Toscanelli (Ital.). | Sends Columbus his map showing the western route to Cathay (China). |
| 1485 | Diego Cam (Port.). | Mouth of the Congo reached. |
| 1487 | Bartholomew Diaz (Port.) | Rounds Cape of Good Hope. |
| 1492–98 | Columbus (Gen.). | America, West Indies, Trinidad, Cuba, etc. |
| 1497–98 | Giovanni Cabot (Anglo-Ven.). | Sails along E. coast of America from Labrador as far as Florida. |
| 1498 | Vasco da Gama (Port.). | Route to India by Cape of Good Hope. |
| 1499 | Amerigo Vespucci (Ital.). | Venezuela, and that America was not "part of Asia." |
| " | Pinzon (Span.). | Discovers mouth of R. Amazon and Cape St. Roque. |
| 1500 | G. Cortereal (Port.). | Reaches entrance of Hudson Strait, called by him Strait of Anian. |
| " | Alvarez Cabral (Port.). | Brazil (named by him Ilha da Vera Cruz, being S. part of Bahia State). |
| 1502 | Columbus (Gen.). | Central America on his fourth voyage. |
| 1512 | Ponce de Leon (Span.). | Florida. |
| 1513 | Portuguese. | Reach the Moluccas. |

THE PROGRESS OF DISCOVERY—*Continued.*

| Date. | Explorer and Nationality. | Discovery or Exploration. |
|---|---|---|
| A.D. | | |
| 1513 | Balboa (Span.) | Crosses Isthmus of Panama and discovers Pacific Ocean. |
| 1516 | Solis (Span.) | Reaches La Plata. |
| 1517 | Sebastian Cabot (Eng.) | Hudson Strait. |
| 1519–21 | Cortez (Span.) | Conquest of Mexico. |
| 1519–21 | Magellan (Span.) | First to circumnavigate the globe. Passes through the Strait of Magellan, crosses the Pacific, and discovers the Philippines. |
| 1534 | Pizarro (Span.) | Completes the Conquest of Peru. |
| 1535 | Diego d'Almagro (Span.) | Conquers Chili. |
| 1535–42 | Jacques Cartier (Fr.) | Gulf of St. Lawrence. Ascends river to Hochelaga (Montreal). |
| 1539 | Francesco de Ulloa (Span.) | Explores Gulf of California. |
| about 1540 | French | Continent of Australia seen by French sailors. |
| 1541 | Pizarro and Orellana (Span.) | Amazon River. |
| 1542 | Antonio de Mota | First reaches Japan. |
| " | Ruy Lopez de Villalobos (Span.) | Discovers Pelew Islands, and takes possession of Philippine Islands for Spain. |
| " | Pinto (Port.) | Visits Japan. |
| 1553 | Sir H. Willoughby (Eng.) | Novaia Zemlia. |
| 1576 | Frobisher (Eng.) | Labrador and Baffin Land. |
| 1577–80 | Sir F. Drake (Eng.) | Second circumnavigation of the globe, and first saw Cape Horn. Explored W. coast of N. America nearly as far as Vancouver Archipelago. |
| 1587 | J. Davis (Eng.) | Davis Strait. |
| 1596 | Barentz and Heemskerk (Dut.) | Spitzbergen, Bear Islands, etc. |
| 1598 | Mendaña (Span.) | Discovers Marquesas Islands. |
| 1606 | Quiros (Span.) | Tahiti (Sagittaria), and other South Sea Islands. |
| " | Torres (Span.) | Torres Strait. Dutch reach Australia. |
| 1608 | Champlain (French) | Discovers Lake Ontario. |
| 1610 | H. Hudson (Eng.) | Hudson Bay and discoveries in N. America. |
| 1614–17 | Spillbergen (Dut.) | Circumnavigation of the globe. |
| 1616 | W. Baffin (Eng.) | Enters Baffin Bay. |
| " | LeMaire and Schouten (Dut.) | Round Cape Horn. |
| " | Dirk Hartog (Dut.) | West coast of Australia. |
| 1618 | G. Thompson (Eng. mer.) | Sails up Gambia. |
| 1642 | Abel Tasman (Dut.) | Van Diemen's Land (Tasmania) and New Zealand. |
| 1643 | Vries (Dut.) | Explores E. coast Japan, Saghalien, and Kurile Is. |
| 1645 | Deshnev (Cossack) | Rounds East Cape of Asia from the Kolyma to the Anadyr. |
| 1660 | French | Lake region of the St. Lawrence discovered. |
| 1673 | Marquette and Joliet (Fr.) | Exploration of the Mississippi from the north. |
| 1725–43 | Russians | Exploration of the coasts of Siberia. |
| 1728 and '41 | Bering (Dan.) and Tishirikov (Rus.) | Bering Strait and the NW. coast of America. |
| 1764–66 | Byron (Eng.) | Circumnavigation of the globe |
| 1768–79 | Capt. Cook (Eng.) | Voyages round the world. Hydrographical surveys of the Society Islands, Sandwich Islands, E. coast of Australia, Cook Strait in New Zealand, Antarctic Ocean, NW. coast of America, etc. |
| 1770 | James Bruce (Scot.) | Sources of the Blue Nile. |
| " | Liakhov (Russian) | Discovers New Siberian Islands. |
| 1785–88 | La Perouse (French) | North of Japan, Saghalien, etc. |
| 1789 | A. Mackenzie (Scot.) | Exploration of the Mackenzie River. |
| 1792 | Vancouver (Eng.) | Vancouver Island circumnavigated. Discovered by Perez, 1774. Exploration of NW. coast of America. |
| 1795–1806 | Mungo Park (Scot.) | Journeys and explorations in the Niger districts. |
| 1799–1804 | Alex. von Humboldt (Ger.) | Explorations in South America and "Cosmos." |
| 1801–1804 | Flinders (Eng.) | Southern coasts of Australia. |
| 1803–6 | Krusenstern (Rus.) | Surveys in Sea of Japan and Sea of Okhotsk, Saghalien, etc. |
| 1805–9 | Salt (Eng.) | Visit to Abyssinia |
| 1807–8 | Klaproth (Ger.) | Exploration of the Caucasus. |
| 1819 | Sir E. Parry (Eng.) | Parry Archipelago. |
| " | Sir J. Franklin | |
| 1825 | Richardson and Back (Eng.) | Coppermine and Mackenzie Rivers explored. |
| 1819 | Long (U. S.) | Exploration of Rocky Mountains. |




THE UNKNOWN WORLD, 1800.

THE PROGRESS OF DISCOVERY—*Continued.*

| Date. | Explorer and Nationality. | Discovery or Exploration. |
|---|---|---|
| 1819 | Wm. Smith (Eng.)..... | South Orkney Islands and South Shetlands. Visited by Weddell in 1822. |
| 1823 | Wrangel (Rus.)..... | Discovers Wrangel Land. |
| 1823 | Denham and Clapperton (Eng.)..... | Lake Chad. |
| 1825–26 | A. G. Laing (Scot.)..... | Reached Timbuktu from Tripoli. |
| 1827–8 | René Caillie (French).... | Journey from Kakandy to Timbuktu and Morocco. |
| 1829 | Sturt (Eng.)..... | Descends the Murrumbidgee and discovers the Murray River. |
| 1830–32 | Biscoe (Eng.)..... | Enderby Land and Graham Land. |
| 1830 | ..... | Royal Geographical Society founded in London. |
| 1831 | Sir J. C. Ross (Eng.)..... | Magnetic North Pole. |
| 1832 | Laird and Oldfield (Scot.). | Exploration of the Niger and Benué. |
| 1833–35 | Sir G. Back (Eng.) ..... | Great Fish River. |
| 1835 | Sir F. Schomburgk (Ger.). | Explorations in Guiana. |

THE UNKNOWN WORLD, 1900.

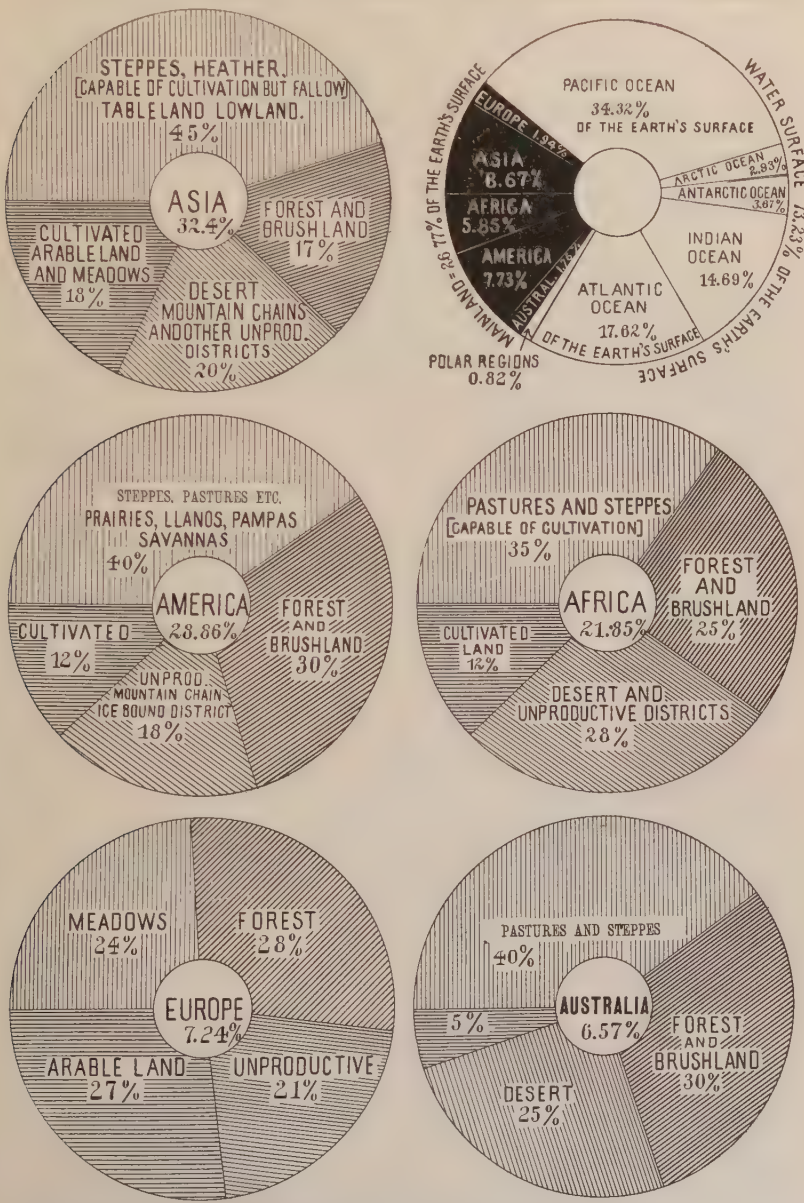
The black areas are unexplored.

The shaded portion represents the radius of a three weeks' journey from London in 1800 and 1900. —*Bartholomew's Atlas.*

THE PROGRESS OF DISCOVERY—*Continued.*

| Date. | Explorer and Nationality. | Discovery or Exploration. |
|---|---|---|
| 1837 | Wood (Eng.) | Sources of the Oxus. |
| 1837–40 | D'Urville (French) | Adélie Land. Reached 66° 30′ S. lat. |
| 1839 | J. Balleny (Eng.) | Balleny Islands, 66° 44′ S. lat. |
| 1839 | Eyre (Eng.) | Discovers Lake Torrens, S. Australia, and in 1841 journeys from Adelaide to King George's Sound. |
| 1840 | Trümmer | Remains of ancient Nineveh. |
| 1841 | Sir James C. Ross (Eng.) | Victoria Land, with volcanoes Erebus and Terror. |
| 1841–73 | D. Livingstone (Scot.) | Thirty years' travel in Central South Africa. |
| 1844–45 | Leichhardt (Ger.) | Crosses Australia, Moreton Bay to Port Essington. |
| 1845 | Sir John Franklin (Eng.) | Sails on his last voyage never to return. |
| 1848 | Rebmann and Krapf (Ger.) | Mt. Kilima Njaro. Sighted Mt. Kenia. |
| 1849–55 | Richardson and Barth (Eng.-Ger.) | Western Sudan and Sahara. |
| 1850 | Sir R. M'Clure (Irish) | Northwest Passage. |
| 1852–4,1861 | Sir C. R. Markham (Eng.) | Explorations in Peru. |
| 1856–59 | Du Chaillu (French) | Basin of Ogowé River, W. Africa |
| 1858 | Sir R. Burton (Scot.) | Lake Tanganyika |
| " | Speke and Grant (Brit.) | Victoria Nyanza. |
| 1860 | Sir S. Baker (Eng.) | Explores Upper Nile. Discovers Albert Nyanza, 1864. |
| 1862 | M'Douall Stuart (Scot.) | Crossed Australia. |
| 1862–63 | W. G. Palgrave (Eng.) | Journeys in Central and Eastern Arabia. |
| 1864–66 | G. Rohlfs (Ger.) | Journey in W. Sudan by Ghadames, Murzuk, and Wadai to R. Niger. |
| 1867–72 | Richthofen (Ger.) | Extensive travel and exploration in China. |
| 1868–71 | G. Schweinfurth (Ger.) | Exploration of the Jur, Niam-Niam, and Monbuttu countries. |
| 1869 | G. Nachtigal (Ger.) | Explorations in Lake Chad region and Central Sudan States. |
| 1870–1886 | Prejevalsky (Rus.) | Journeys in Mongolia, Tibet, etc. |
| 1871–75 | Leigh Smith (Eng.) | Exploration of N. part of Spitzbergen. Vaigats Is. |
| 1872 | Payer and Weyprecht (Austrian) | Franz Josef Land. |
| 1872–76 | "Challenger" Expedition (Brit.) | Explores the depths of the oceans. |
| 1872–76 | Ernest Giles | Traverses Northwest Australia. |
| 1873 | Warburton (Irish) | Crosses Western Australia from East to West. |
| 1874–75 | Lieut. Cameron (Eng.) | Crosses Equatorial Africa. |
| 1876 | De Breeze (French) | Explorations in the Ogowé and Gabun region. |
| 1876–90 | H. M. Stanley (Eng.) | Congo Basin; Mt. Ruwenzori; Forests on the Aruwimi, etc. |
| 1876 | Sir Geo. Nares and A. H. Markham (Eng.) | Grant Land. Penetrated as far N. as 83° 20′ lat. |
| 1878–79 | Nordenskjöld (Swed.) | Northeast passage. |
| 1878–89 | Thomson (Scot.) | Journeys through Masai Land, British South Africa, Sokoto, Morocco, etc. |
| 1878–85 | Major Serpa Pinto (Port.) | Twice crosses Africa. |
| 1878–92 | Emin Pasha (Ger.) | Travels and Surveys in Equatorial Africa. Discovery of Semliki River, etc. |
| 1879 | Moustier and Zweifel (Swiss) | Sources of the Niger. |
| 1881–85 | Greely (U. S.) | Grinnell Land and NE. coast of Greenland. |
| 1885 | Wiesmann (Ger.) | Across Africa from West coast, Congo Basin. |
| " | Junker (Rus.-Ger.) | Welle-Mobangi, etc. |
| 1886 | Peary (U. S.) | North Greenland. |
| 1887 | Capt. Younghusband (Eng.) | Travels from Pekin to Kashmir. |
| 1893–96 | Nansen (Norw.) | Hviotenland, etc.; reached his "Farthest North" in lat. 86° 13′ 6″ N. |
| 1897 | Jackson (Scot.) | Surveys and explorations in Franz Josef Land. |
| 1893–97 | Sven Hedin (Swed.) | Explorations in North Central Asia. |
| 1895–96 | Pr. Henri d'Orléans | Travels in Tonkin and China. |
| 1896 | Donaldson Smith (Scot.) | Explores region of Lake Rudolf. |
| 1896–98 | Capt. Marchand | Travels from Upper Mobangi to Fashoda. |
| 1897 | Andrée (Swed.) | Attempt to cross over the North Pole in a balloon, with fatal results. |
| 1897 | D. Carnegie | Crosses Western Australia from S. to N. |
| 1898–99 | De Gerlache (Belgian) | "Belgica," first ship to winter within Antarctic circle. |
| 1899 | Major Gibbons | Explorations in Congo and Zambezi headwaters. |
| 1900 | Borchgrevink (Brit. Ex.) | Reached lat. 78° 50′ S. via Victoria Land. |
| " | Duke of Abruzzi (Ital.) | Reached lat. 86° 33′ N. via Franz Josef Land. |
| 1900–02 | Sven Hedin (Swed.) | Important Journey in Central Asia. |

*—Bartholomew's Atlas.*

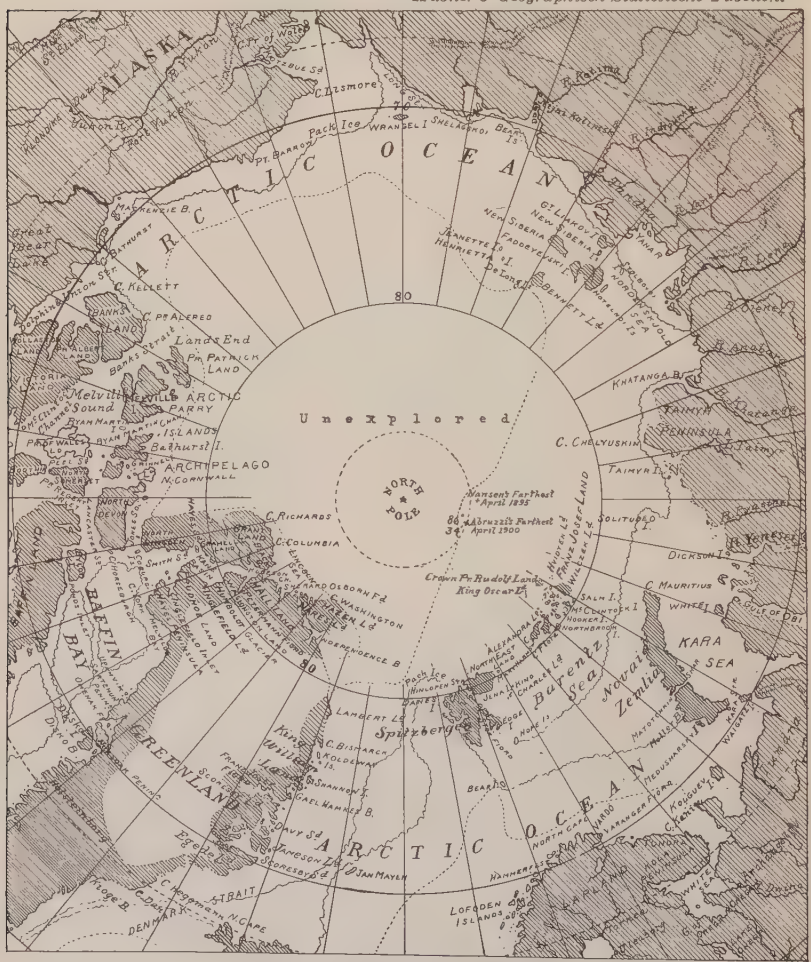



DISTRIBUTION OF LAND AND WATER OF THE EARTH'S SURFACE AND THE DIVISION OF LAND IN FIVE CONTINENTS.

## TOTAL AREAS AND POPULATION OF THE POLAR REGIONS.

| | Square Miles. | Square Kilometers. | Population. In Thousands. | Population. Per Square Mile. | Population. Per Square Kilo. |
|---|---|---|---|---|---|
| (1) Under no sovereignty | 1,103,554 | 2,858,210 | .... | .... | .... |
| (2) Danish possessions on Greenland | 34,015 | 88,100 | 12 | 0.3 | 0.1 |
| (3) British possessions: | | | | | |
| Arctic Island in North America | 502,354 | 1,301,100 | 1 | 0.00 | 0.00 |
| South Georgia | 1,573 | 4,075 | .... | .... | .... |
| (4) Russian possessions in the Arctic Ocean (New Siberian Islands) | 14,895 | 38,580 | .... | .... | .... |
| | 1,656,391 | 4,290,065 | 13 | 0.3 | 0.1 |

*—Hübner's Geographisch-Statistische Tabellen.*




MAP OF THE ARCTIC REGIONS. *—Bartholomew's Atlas.*

## THE POLAR REGIONS.

National emulation, more particularly since the great success of Nansen, seems to have played the chief role in all the recent researches undertaken in the vicinity of the poles.

No fewer than three expeditions were organized in 1902 for the main purpose of reaching the North Pole. Otto Sverdrup, the Norwegian, with Nansen's old ship, the "Fram," started in through Smith Sound; Lieut. Robert E. Peary, of the United States navy, pursued a like course; while Mr. E. B. Baldwin, also an American, selected Franz Josef Land as his point of departure, although Prince Luigi, of Savoy, had only just vainly attempted it.

The expedition led by Capt. Sverdrup was incontestably the most successful, says Dr. Herman Haack in his Geographen Kalender. As early as 1898 his expedition was already under way. He spent the first winter north of Cape Sabine, where, by means of extended sledge journeys, he explored the fiords of Hayes Sound, in the following spring even advancing as far as the west coast of Ellesmereland. Finding the ice conditions no more favorable in 1899 than in the previous summer, he abandoned forthwith his former plan and fixed upon Jones Sound as the starting point for his investigations, in the hope of finding on the west coast of Ellesmereland a better and freer water course to the north than the narrow neck of Smith Sound can afford, which is so easily obstructed by the pack ice from the Pole. Sverdrup met with difficulties in Jones Sound also, for he could push no farther forward than Inglefeld had reached in 1852, and so he took up his second winter quarters at the point where the coast of Ellesmereland seemed to bend northward, under north latitude 76 deg. 29 min. and west longitude 84 deg. 24 min.

The sledge journeys of the fall of that year established the fact that Ellesmereland extended much farther westward than was supposed, and was separated from North Kent only by the Belcher Channel, a small arm of the sea. In the spring of 1900 Sverdrup continued the exploration of the west coast of Ellesmereland, where he discovered a deep fiord, while his assistant, Isachsen, examined a large body of land lying to the west of it. The "Fram" being free from ice in August, the passage through Jones Sound was continued, but the ship was soon fast again in the Belcher Channel near the westernmost point of Ellesmereland, and Sverdrup established his third winter quarters under latitude 76 deg. 48 min. and longitude 89 deg. The fall of 1900 and the spring of 1901 were devoted to sledge journeys.

Sverdrup himself continued his exploration of Ellesmereland, examining anew and more thoroughly the fiord which he discovered the year before, after which he turned northward and succeeded in reaching the most westerly point occupied by him in the spring of 1899, to which he had then proceeded from Smith Sound.

Isachsen proceeded westward and discovered north of North Cornwall two larger islands, exploring their southern coasts till they turned toward the north. Under latitude 79 deg. 30 min. and longitude 106 deg., he reached his farthest western limit, from which point neither to the west nor to the north was any land visible, and from the character of the floating ice it was not probable that any land existed in either direction. In July of that year the north coast of North Devon was explored in boats.

All attempts to get the "Fram" out of the ice having failed, Sverdrup was compelled to pass a fourth winter in 1901-2 in this region, during which other extended sledge journeys were undertaken. Following the west coast of Ellesmereland, Sverdrup attempted to reach 80 deg. 16 min. N., 85 deg. 33 min. W., the farthest point attained by Lieut. Aldrich, of the English Polar Expedition of 1875-76, on the west coast of Grinnell Land, coming down from the north. He was not successful, however, though he penetrated as far north as 80 deg. 37 min., which was but a short distance from the goal. Sledge journeys undertaken by other participants in the expedition resulted in the exploration of the west coast of North Devon. In the beginning of August, 1902, when the "Fram" was again free from ice, Sverdrup started immediately upon his homeward way, reaching Stavanger on the 19th of September. The chief result of this expedition was the discovery of large land areas west of Ellesmereland, and since the discovery of Franz Josef Land no such extension of our knowl-

edge of these regions has been signalized.

Lieut. Robert N. Peary, U. S. N., conceived a plan of reaching the North Pole by sledge journeys, accompanied by no one but Esquimaux and his black servant Henson. For this purpose it became necessary to establish, well to the south, a point of departure that could be reached every year by a ship, which could supply fresh provisions and new outfittings, that were to be pushed toward the north and deposited in caches along the coast. The weak point of the scheme lay in the fact that the advance to the farthest points already reached required so much time for so small a sledge crew that further penetration into the unknown must be undertaken at an advanced season of the year, when the stability of the ice made such a movement questionable. The winter of 1898-99 Peary passed at Etah, on the eastern shore of Smith Sound, in order to interest the aborigines in his plan, buy dogs, and perfect other preparations. After his ship, the "Windward," reached him with fresh supplies in the fall of 1899, he was transported to Cape Sabine, which he had fixed upon as the starting point and base of the expedition. Here he passed the winter of 1899-1900. In the spring of 1900 he undertook a sledge journey straight across Ellesmereland, and in the fall of that year established a line of depots toward the north. In the spring of 1901 he made the first energetic move toward the Pole, which led him from Grant Land in the direction of Greenland. He passed the most northern point, 83 deg. 24 min., reached by Lockwood in the Greely expedition of 1882, and fixed, under latitude 83 deg. 39 min., the northern extremity of Greenland. He followed the coast toward the east until it began to bend decidedly to the southeast in the direction of Independence Bay, thus establishing the insular nature of Greenland.

On his return he made a dash for the north and reached 83 deg. 50 min., the highest point thus far attained on the American side of the polar archipelago. During the spring of 1902, Peary even exceeded this. Starting from Cape Hekla, the northernmost point of Grant Land, he proceeded over the ice as far as 84 deg. 17 min., while Capt. Markham, in 1876, succeeded only in reaching 83 deg. 20 min. from this side. From the European side, however, Capt. Cagni, of the Italian expedition, starting from Franz Josef Land, attained the advanced position of 86 deg. 34 min.

Peary was obliged to make his dash in April, and, as was the case with Markham, he found the ice in a very unsatisfactory condition; the immense hummocks of compressed drift-ice increased the difficulties of travel for both dogs and men. There were no traces, however, of the unchangeable paleocrystic ice mentioned by Markham, for on the return Peary met with numerous open places and channels which caused serious delays. No land was visible to the north of either Greenland or Grant Land. In spite of the unsuccessful termination of his expedition, Peary is still convinced that the best point of departure is from the American side of the archipelago, and, moreover, that, with an early start from Grant Land, the Pole may be reached by sledge. Though Sverdrup and Peary added to our knowledge of the Polar regions, the third expedition fitted out by Mr. Ziegler, an American, and under the direction of Mr. Baldwin, who started from Franz Josef Land for the Pole, was closed without definite results. Several small islands were discovered; the hut in which Nansen and Johansen lived in 1895-6 was again found; some scientific events were noted; meteorological sketches and photographs of the Northern Lights were made, and yet the finality of the expedition was a fiasco. No earnest attempt to reach the Pole was made. Serious friction between Baldwin and Fridtjof, the sailing master of the expedition, is responsible for the unsuccessful termination.

Among the most important of the Polar expeditions is that led by Baron Toll, a Russian, for the discovery and exploration of the island either existing or supposed to exist to the north of the New Siberian Islands. Having twice before, in 1886 and 1894, visited the northernmost of these islands, Toll left Europe again in 1900 in the steamship "Sarja" upon a similar quest. Upon entering the Sea of Kara, he did not pick up the ship which was bringing him coal, and since both the condition of the ice and the open sea were favorable to his designs, he preferred not to wait for it. Cape Tscheljuskin, the extreme northern point of Asia, and the intended termination of the first summer's journey, was not reached, but the condition of the ice

compelled him to put into Colin-Archer haven, at the entrance to the Taimyr Straits, on September 26, where he passed the winter.

Failing in two attempts to gain the mouth of the Jenissei by crossing the land, Lieutenant Kolomeizoff finally reached it by following the coast. During the spring of 1901, the extent of Taimyr Bay was carefully explored upon sleds, and through the discovery of the hut in which Lapten spent the winter of 1840-1, as well as by reaching the most northern station of the Middendorf expedition of 1843, the mouth of the Taimyr River was definitely fixed. The "Sarja" could not proceed till August 25. Cape Tscheljuskin was safely rounded and the course set for the location where, according to Toll's observation in 1886, the distant Polarland, seen as early as 1811 by Sannikow, to the north of Kotelny, ought to be. This point was passed without sighting the supposed land, and a few miles before reaching Cape Emma, the southernmost point on Bennett Island, discovered by the "Jeannette" expedition, the ice became so packed that further progress northward was impossible. On the return voyage the ship cruised again in the vicinity of the supposed Sannikow land, but without sighting it. On September 24, 1901, the "Sarja" froze in at the island of Kotelny, in Nerpitscha Bay, where the expedition passed the winter. Whether or not Sannikow and Toll were deceived as to what they saw cannot yet be determined. It is quite possible that they may have miscalculated the distance and that the island may lie farther north in a section not touched even by Nansen's drift in the "Fram" during the long winter night of his journey in 1893-4. Being unable to get coal from the Lena River, the "Sarja" became unfit for long journeys; accordingly Toll resolved upon sledge journeys to the north, similar to those undertaken from the "Fram" by Nansen. The geologist, Birula, began such a journey May 11, intending to explore the largest of the New Siberian Islands. On June 5 Toll followed him, accompanied by the astronomer Seeberg and two Jakuts, but touched only at the northernmost point, Cape Wyssoki, which he left on July 13, crossing the ice for Bennett Island. Toll left Lieut. F. Mattheissen in charge of the "Sarja," but August 21 arrived before any earnest effort could be made to proceed to New Siberia and Bennett Land to bring back the sledge parties. About Kotelny and Faddejew the ice was so thick that these islands could be passed neither to the north nor the south, and since the open season was fast drawing to a close, Mattheissen brought the "Sarja" back to the Lena, where he anchored in the bay of Tiksi September 8. Being too deep of draft to steam up the river, the "Sarja" was abandoned, and the crew, together with the scientific collection and instruments, were transferred to Jakutsk on the small steamer "Lena."

It was expected that Toll and Birula would return to the mainland at the beginning of winter, but Birula returned in 1903, in good health, without having seen Toll. Perhaps the condition of the ice between Bennett Land and New Siberia prevented Toll's return, and it was held that he would attempt it again in the spring of 1903.

## THE GREAT [LAURENTIAN] LAKES.

| Lakes. | Length, Miles. | Breadth, Miles. | Area, Sq. Miles. | Height above Sea, Feet. |
|---|---|---|---|---|
| Superior | 390 | 160 | 31,420 | 602¾ |
| Huron (with Georgian Bay) | 400 | 160 | 24,000 | 576¼ |
| St. Clair | 25 | 25 | 360 | 570¼ |
| Erie | 250 | 60 | 10,000 | 566¼ |
| Ontario | 190 | 52 | 7,330 | 240 |
| Michigan | 345 | 58 | 25,590 | 578¼ |

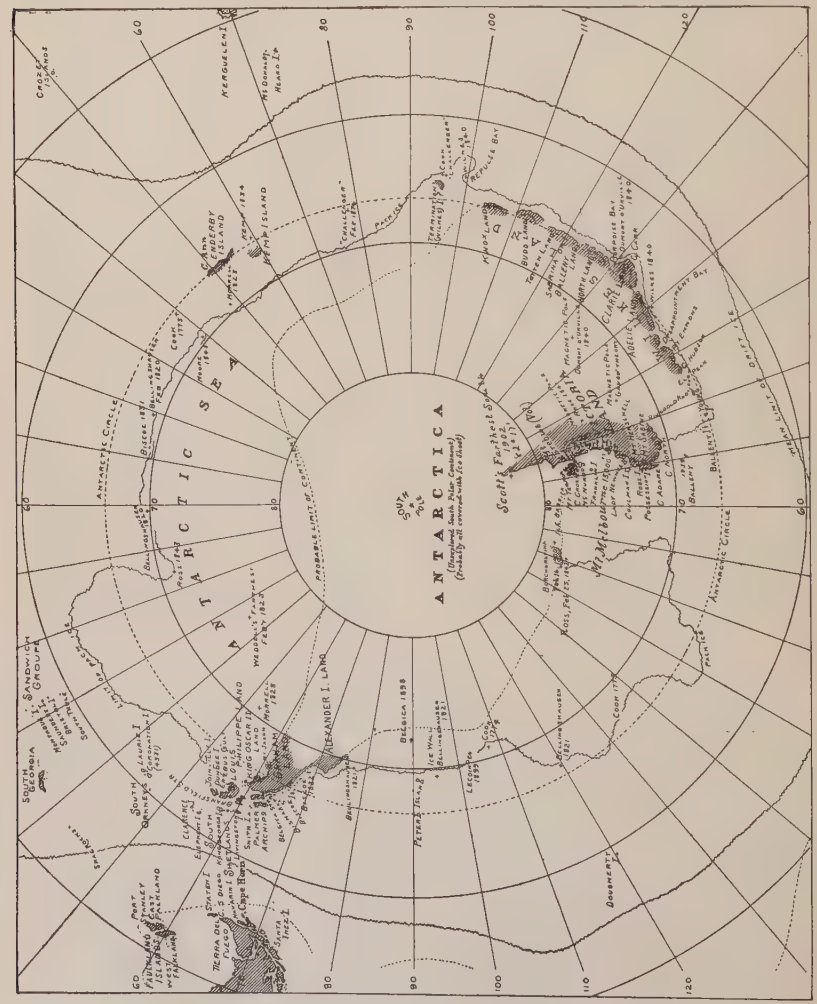
Lake Michigan is wholly within the United States and is connected with Lake Huron by the Strait of Mackinaw.

—*Statistical Year Book of Canada.*

## ANTARCTIC EXPLORATIONS.

Though the quest of the North Pole has monopolized the world's attention for more than a century, it has of late not been entirely without a rival. The British expedition broke the farthest-south record by reaching the latitude of 82 deg. 17 min. Mr. Borchgrevink previously held the record at 78 deg. 51 min.

THE BRITISH EXPEDITION sailed from London in July, 1901, on the Discovery, under command of Capt. Scott, R. N. Fearful lest the currents might destroy the expedition, a rescuing party was dispatched in 1902 under Lieut. William Colbeck, who took part in the Borchgrevink South Polar expedition. The rescuers on the Morn-


ANTARCTICA
SOUTH POLE
ANTARCTIC CIRCLE
ANTARCTIC OCEAN
BRITISH SEA
Scott's Farthest South 1902 (82° 17')
(Highest point reached by Shackleton 1909 (Probably all covered with ice sheet))
PROBABLE LIMIT OF CONTINENT
Mt. Markham
Mt. Parry
Mt. Nansen
Mt. Lister
Mt. Longstaff
Mt. Buchanan
Mt. Kirkpatrick
Mt. Hope
Mt. Sidley
Mt. Erebus
Mt. Terror
Mt. Haddington
Mt. Melbourne
Mt. Murchison
Mt. Bird
Mt. Minto
Mt. Lyell
Mt. Sabine
Mt. Herschel
Mt. Darwin
Mt. Wilson
Mt. Dickason
Mt. Bowers

ing left Wellington, December 6, 1902, and returned to the same place March 25, 1903, bringing reports of the successful work of the main expedition. The Discovery reached Cape Adare, the northernmost point of Victoria Land, January 9, 1902, and followed the coast south; from Mt. Erebus the ship skirted the wall of ice, discovered by Ross, as far as longitude 165 deg. E., where it turned more to the north. Behind the ice wall reared the highlands covered with glaciers which Ross had sighted.

Under 67 deg. N. and 152 deg. 30 min. E. the ship reached its farthest point, whence it returned to Victoria Land to go into winter quarters in MacMurdo Bay, near the volcano Mt. Erebus, in longitude 174 deg. E.

Sledge journeys began in September, 1902. The one led by Captain Scott marched for three months, attaining a point under 82 deg. 17 min., which surpassed Borchgrevink's 78 deg. 50 min. by nearly 3½ deg. A second sledge party, commanded by Lieutenant Armitage, turned westward of Erebus, and during a march of fifty-two days reached an elevation of 9,000 feet. This is the more noteworthy since all the dogs died, supposedly from spoiled provisions. The Morning found the Discovery still in winter quarters, and when the rescuers departed the Discovery seemed still fast in the ice.

Late in 1903 the Morning and the whaler Terra Nova were refitted and started on a second expedition to the relief of the Discovery. The latter was found on February 14 and the three vessels returned to Lyttleton, New Zealand, on April 1, 1904. Among the chief results of the expedition was the discovery that Mount Erebus and Mount Terror are on a small island, and that there is a large land mass lying west and southwest of the ice barrier, with ice plateaus 9,000 feet in height and peaks which reach to 14,000. It was discovered that the ice barrier is afloat, though fed from land, and that high land lies to the southeast of the hitherto unknown extremity of the barrier.

THE GERMAN EXPEDITION,

which entered the ice-pack south of the Indian Ocean on February 13, 1902, left it on April 9, 1903, and returned from a voyage highly fruitful of scientific results, although not comparable with the voyage of the Discovery in sensational experiences. Incidentally it has swept away the Termination Land of Wilkes, passed the winter in the close pack, carried out numerous and important sledge journeys, discovered new land (called Kaiser Wilhelm II. Coast), and actually reached land in the solitary peak called the Gaussberg. Balloons were used successfully during the expedition. The farthest south was 66 deg. 2 min., and the ship was frozen for many months in ice 30 feet thick.

THE SWEDISH EXPEDITION,

under Captain Otto Nordenskjöld, left Europe in October, 1901, and entered the Antarctic regions in February, 1902. The ship returned from the Falkland Islands to Graham's Land in March, 1902, went south again in the southern summer of 1902-1903. With the assistance of the Swedish government the Norwegian steamer Frithjof was dispatched for the relief of the Antarctic, whose commander, by the way, is Captain Larsen, well known for his Antarctic voyage in the Jason. To the Republic of Argentine, which sent the gunboat Uraguay, belongs the honor of having rescued the Swedish expedition, which was found at Snow Hill on Louis Philippe Land in desperate straits, their vessel having been crushed by the ice and sunk on February 12, 1903.

THE SCOTTISH EXPEDITION,

on the Scotia, under the command of Mr. W. S. Bruse (formerly of the Jackson-Harmsworth expedition), set sail on November 3, 1902, for what is known as the Weddell quadrant of the Antarctic regions, with the intention of following in the wake of Captain Jas. Weddell, who reached a high southern latitude in open sea. This route was advisedly selected, as the Scottish expedition is devoting its attention to oceanographical work. Captain Robertson, the well-known whaling skipper, commanded the Scotia. Contrary to expectation, the Scotia wintered in the ice, and no further news of her has yet been received.

THE FRENCH EXPEDITION,

under the command of Dr. Charcot, sailed from Havre in August, 1903, to explore Alexander Land. The original plan of the expedition was to explore Nova Zembla, but just then the Swedish expedition was causing a great deal of anxiety, and it was decided to direct the expedition toward the South Pole in search of Nordenskjöld. The rescue of the Swedish expedition then left Dr. Charcot free to make explorations in Antarctic regions.

## AREA AND POPULATION OF THE PRINCIPAL COUNTRIES COMMERCE WITH

Revised and Corrected by the Bureau of

| Countries. | Area and Population. | | |
|---|---|---|---|
| | Area. | Population. | Population per Square Mile. |
| | *Sq. Miles.* | | |
| Argentina | 1,135,840 | 4,794,000 | 4.22 |
| Australasia: Commonwealth | 2,972,573 | 3,772,000 | 1.27 |
| New Zealand | 104,751 | 788,000 | 7.52 |
| Austria-Hungary | 241,333 | 45,405,000 | 188.14 |
| Austria | [2a] 115,903 | [2a] 26,151,000 | 225.63 |
| Hungary | [2a] 125,430 | [2a] 19,254,000 | 153.51 |
| Belgium | 11,373 | 6,694,000 | 588.59 |
| Bolivia | 703,604 | 1,816,000 | 2.58 |
| Brazil | 3,219,000 | 14,334,000 | 4.45 |
| British colonies, n. e. s. | 951,333 | 14,434,000 | 15.17 |
| Bulgaria | 38,080 | 3,744,000 | 98.33 |
| Canada | 3,048,710 | 5,457,000 | 1.79 |
| Central America: Costa Rica | 23,000 | 313,000 | 13.61 |
| Guatemala | 46,774 | 1,647,000 | 35.21 |
| Honduras | 46,250 | 775,000 | 16.76 |
| Nicaragua | 49,200 | [19] 500,000 | 10.16 |
| San Salvador | 7,225 | 1,007,000 | 139.38 |
| Chile | 279,901 | 3,051,000 | 10.90 |
| China | 1,532,420 | 407,253,000 | 265.76 |
| Colombia | 504,773 | [9] 4,000,000 | 7.92 |
| Cuba | 43,000 | 1,573,000 | 36.58 |
| Denmark | 15,360 | 2,465,000 | 160.48 |
| Ecuador | 116,000 | 1,204,000 | 10.38 |
| Egypt | 383,900 | 9,734,000 | 25.36 |
| Finland | 144,255 | 2,744,000 | 19.02 |
| France | 207,054 | 38,962,000 | 188.17 |
| Algeria | 184,474 | 4,739,000 | 25.69 |
| Tunis | 51,000 | 1,900,000 | 37.25 |
| French colonies, n. e. s. | 3,375,602 | 26,427,000 | 7.83 |
| French East Indies [6] | 461,196 | 18,346,000 | 39.78 |
| German Empire | 208,830 | 58,549,000 | 280.36 |
| German colonies | 1,025,829 | 13,543,000 | 13.20 |
| Greece | 25,014 | 2,434,000 | 97.31 |
| Haiti | 10,204 | 1,294,000 | 126.81 |
| India, British [7] | 1,766,642 | 294,361,000 | 166.62 |
| Italy | 110,646 | 32,475,000 | 293.50 |
| Japan | 147,655 | 45,862,000 | 310.60 |
| Formosa | 13,458 | 2,706,000 | 201.07 |
| Korea | 84,400 | [9] 12,000,000 | 142.18 |
| Mexico | 767,060 | 13,545,000 | 17.65 |
| Netherlands | 12,563 | 5,347,000 | 425.61 |
| Dutch East Indies | 736,400 | 35,736,000 | 48.53 |
| Norway | 124,130 | 2,263,000 | 18.23 |
| Paraguay | 97,722 | 636,000 | 6.51 |
| Persia | 628,000 | [9] 9,500,000 | 15.13 |
| Peru | 713,859 | 4,610,000 | 6.46 |
| Portugal | 36,038 | 5,429,000 | 150.65 |
| Roumania | 50,700 | 5,913,000 | 116.63 |
| Russia | 8,660,395 | 141,000,000 | 16.28 |
| Santo Domingo | 18,045 | 610,000 | 33.80 |
| Servia | 18,630 | 2,536,000 | 136.12 |
| Siam | 236,000 | 5,000,000 | 21.19 |
| Spain | 194,783 | 18,618,000 | 95.58 |
| Sweden | 172,876 | 5,199,000 | 30.07 |
| Switzerland | 15,976 | 3,356,000 | 210.07 |
| Turkey | 1,115,046 | 24,932,000 | 22.36 |
| United Kingdom | 121,371 | 41,961,000 | 345.73 |
| United States | [8a] 3,025,600 | 80,372,000 | 26.56 |
| Philippine Islands | 115,000 | 7,590,000 | 66.00 |
| Uruguay | 72,210 | 959,000 | 13.28 |
| Venezuela | 593,940 | 2,445,000 | 4.12 |
| Total | 41,414,336 | 1,508,659,000 | ..... |

[1] Exclusive of intercolonial commerce, but including gold and silver. [2] Including gold [5] French Africa. [6] Includes French possessions in India and French Indo-China, viz., the feudatory States. [8] Included under Sweden. [8a] Exclusive of Alaska and Hawaii.

## OF THE WORLD, THEIR TOTAL FOREIGN COMMERCE, AND THE UNITED STATES.

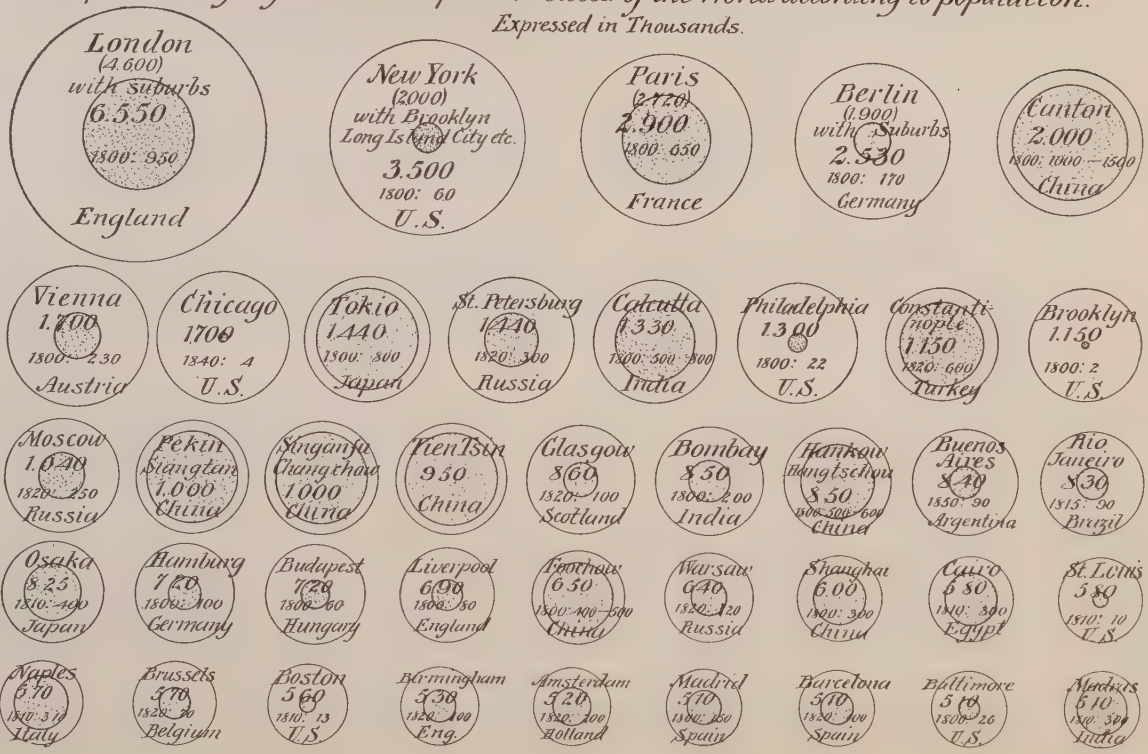
Statistics, Department of Commerce and Labor.

| Year. | Foreign Commerce. Imports. | Exports. | Excess of Exports (+) or Imports (−). | Commerce with the United States. Exports from United States to. | Imports into United States from. |
|---|---|---|---|---|---|
| | *Dollars.* | *Dollars.* | *Dollars.* | *Dollars.* | *Dollars.* |
| 1903 | 126,614,000 | 213,250,000 | + 86,636,000 | 14,271,777 | 9,297,456 |
| 1902 | [1] 203,644,000 | [1] 213,713,000 | + 10,069,000 | 28,101,784 | [2] 13,845,001 |
| 1902 | [2] 55,121,000 | [2] 66,403,000 | + 11,282,000 | | |
| 1903 | 381,054,000 | 432,345,000 | + 51,291,000 | 7,893,753 | 10,697,288 |
| ..... | ..... | ..... | ..... | ..... | ..... |
| ..... | ..... | ..... | ..... | ..... | ..... |
| 1903 | 512,679,000 | 407,295,000 | − 105,384,000 | 45,853,856 | 24,072,641 |
| 1902 | 5,587,000 | 11,076,000 | + 5,489,000 | 76,926 | 1,731 |
| 1903 | 120,747,000 | 180,219,000 | + 59,472,000 | 10,486,755 | 69,636,414 |
| 1902 | 475,370,000 | 280,744,000 | − 194,626,000 | 57,886,757 | 22,875,024 |
| 1903 | 15,788,000 | 20,858,000 | + 5,070,000 | ..... | ..... |
| [3] 1904 | 243,590,000 | 177,833,000 | − 65,757,000 | 131,234,985 | 51,552,791 |
| 1902 | 4,415,000 | 5,661,000 | + 1,246,000 | 1,697,043 | 3,291,545 |
| 1900 | 3,018,000 | 7,134,000 | + 4,116,000 | 1,128,418 | 2,190,145 |
| 1902 | 1,672,000 | 2,357,000 | + 685,000 | 969,963 | 1,136,220 |
| 1902 | 2,170,000 | 4,061,000 | + 1,891,000 | 1,360,686 | 1,858,729 |
| 1902 | 2,624,000 | 3,926,000 | + 1,302,000 | 868,329 | 583,459 |
| 1902 | 48,336,000 | 67,846,000 | + 19,510,000 | 3,753,222 | 7,160,771 |
| 1903 | 217,607,000 | 138,472,000 | − 79,135,000 | 14,970,138 | 24,985,510 |
| 1898 | 10,695,000 | 18,487,000 | + 7,792,000 | 2,923,404 | 4,810,465 |
| [3] 1903 | 58,826,000 | 77,849,000 | + 19,023,000 | 21,761,638 | 62,942,790 |
| 1903 | 119,180,000 | 94,470,000 | − 24,710,000 | 14,411,599 | 686,915 |
| 1902 | 7,029,000 | 8,811,000 | + 1,782,000 | 1,347,850 | 1,823,166 |
| 1903 | 82,811,000 | 96,584,000 | + 13,773,000 | 744,260 | 9,052,419 |
| 1902 | 51,573,000 | 41,150,000 | − 10,423,000 | [4] | [4] |
| 1903 | 926,632,000 | 820,685,000 | − 105,947,000 | 88,690,130 | 80,083,966 |
| 1903 | 66,704,000 | 55,526,000 | − 11,178,000 | [5] 408,059 | [5] 359,050 |
| 1903 | 16,137,000 | 13,780,000 | − 2,357,000 | | |
| 1902 | 43,449,000 | 35,394,000 | − 8,055,000 | 2,398,660 | 627,391 |
| 1902 | 42,387,000 | 41,074,000 | − 1,313,000 | 62,361 | 3,873 |
| 1903 | 1,428,640,000 | 1,193,483,000 | − 235,157,000 | 224,562,019 | 122,272,313 |
| 1902 | 10,193,000 | 5,264,000 | − 4,929,000 | 102,639 | 27,032 |
| 1902 | 26,485,000 | 15,375,000 | − 11,110,000 | 369,919 | 1,299,144 |
| 1901 | 5,500,000 | 12,760,000 | + 7,260,000 | 1,956,343 | 1,127,641 |
| [1]902–3 | 278,054,000 | 409,535,000 | + 131,481,000 | 4,866,683 | 51,831,665 |
| 1903 | 359,358,000 | 292,867,000 | − 66,491,000 | 36,041,878 | 33,655,910 |
| 1903 | 157,933,000 | 142,414,000 | − 15,519,000 | 20,874,887 | 45,510,768 |
| 1903 | 10,940,000 | 10,346,000 | − 594,000 | | |
| 1902 | 6,744,000 | 4,142,000 | − 2,602,000 | 257,130 | ..... |
| [3] 1903 | 74,690,000 | 83,366,000 | + 8,676,000 | [2] 43,124,985 | [2] 71,118,819 |
| 1903 | 912,376,000 | 781,750,000 | − 130,626,000 | 72,961,060 | 20,862,867 |
| 1902 | 72,545,000 | 95,102,000 | + 22,557,000 | 1,597,299 | 14,212,864 |
| 1903 | 76,670,000 | 46,531,000 | − 30,139,000 | [8] | [8] |
| 1902 | 2,270,000 | 3,787,000 | + 1,517,000 | 14,815 | 3,890 |
| 1902 | 23,703,000 | 13,243,000 | − 10,460,000 | ..... | ..... |
| 1903 | 18,412,000 | 18,774,000 | + 362,000 | 3,471,135 | 3,265,386 |
| 1902 | 60,044,000 | 30,710,000 | − 29,334,000 | 2,915,897 | 3,229,813 |
| 1903 | 52,095,000 | 68,637,000 | + 16,542,000 | 202,735 | 113,098 |
| 1902 | 308,563,000 | 443,066,000 | + 134,503,000 | 14,313,501 | 7,837,844 |
| 1901 | 2,987,000 | 5,224,000 | + 2,237,000 | 1,700,371 | 3,361,319 |
| 1902 | 8,650,000 | 13,920,000 | + 5,270,000 | ..... | 33,149 |
| 1902 | 15,782,000 | 21,103,000 | + 5,321,000 | ..... | ..... |
| 1903 | 185,632,000 | 178,651,000 | − 6,981,000 | 18,297,940 | 8,750,729 |
| 1902 | 143,351,000 | 118,309,000 | − 25,042,000 | 10,435,944 | 5,370,071 |
| 1903 | 230,860,000 | 171,485,000 | − 59,375,000 | 413,748 | 21,155,994 |
| 1899–1900 | 107,873,000 | 68,821,000 | − 39,052,000 | 562,956 | 6,694,007 |
| 1903 | 2,640,564,000 | 1,415,179,000 | −1,225,385,000 | 543,766,877 | 176,723,465 |
| [3] 1904 | 991,087,000 | 1,435,179,000 | + 444,092,000 | ..... | ..... |
| [3] 1904 | 33,221,000 | 30,251,000 | − 2,970,000 | 4,832,900 | 12,066,934 |
| 1903 | 25,958,000 | 38,587,000 | + 12,629,000 | 1,901,651 | 2,573,431 |
| 1898 | 8,560,000 | 14,900,000 | + 6,340,000 | 2,736,726 | 6,609,919 |
| ..... ... | 12,125,199,000 | 10,719,764,000 | −1,405,435,000 | 1,465,584,391 | 1,023,282,832 |

and silver. [2a] Not included in total. [3] Year ending June 30. [4] Included under Russia. Cochin China, Tonkin, Annam, Cambodia, and Laos. [7] Including area and population of [9] Estimated.

## Comparative sizes of the most important Cities of the World according to population.

Expressed in Thousands.



# CHAPTER II.

## SHIPPING AND YACHTS.

### SUMMARY OF SHIPPING.

The growth of our merchant marine is slow, and is in no sense commensurate with our phenomenal advancement in manufactures and commerce. At the same time, it is a fact worthy of note that the documented tonnage of the United States on June 30, 1903, for the first time in our history exceeded 6,000,000 gross tons register, comprising 24,425 vessels of 6,087,345 gross tons. These figures do not include 1,828 yachts of 74,990 gross tons. The total shipping of the United Kingdom for 1902 was 20,258 vessels, of 15,357,052 gross tons (vessels of British colonies number 15,533 of 512,268 net tons). On January 1, 1902, the total shipping of the German Empire was 6,024 vessels of 3,503,551 gross tons. The shipping of the United Kingdom and Germany is largely employed in developing foreign trade. The shipping of the United States is almost wholly a part of our domestic transportation system. On June 30, 1904, 6,291,535 gross tons were engaged in transportation and coastwise trade, 977,624 gross tons were devoted to foreign trade, and 86,524 to fisheries. The distribution of our tonnage on June 30, 1904, was: Atlantic Ocean, 3,244,928 gross tons; Pacific Ocean, 775,255 gross tons; the Great Lakes, 2,019,208 gross tons; Western Rivers, 213,384 gross tons. In regard to motive power, 3,595,418 gross tons were propelled by steam, and 2,696,117 gross tons were sailing vessels, and 751,161 gross tons of canal-boats and barges were variously propelled. As regards the materials of construction, 3,622,956 gross tons were of iron and steel construction, and 3,622,956 gross tons were of wood. The following table shows the geographical distribution, motive power, and material of construction of American shipping June 30, 1904:

| American Shipping. | Number. | Gross Tonnage. |
|---|---|---|
| GEOGRAPHICAL DISTRIBUTION. | | |
| Atlantic and Gulf coasts. | 17,330 | 3,244,928 |
| Porto Rico | 66 | 7,438 |
| Pacific coast | 2,542 | 775,255 |
| Hawaiian Islands | 61 | 31,322 |
| Northern lakes | 3,075 | 2,019,208 |
| Western rivers | 1,484 | 213,384 |
| Total | 24,558 | 6,291,535 |
| POWER AND MATERIAL. | | |
| Sail: | | |
| Wood | 15,900 | 2,389,131 |
| Iron and steel | 195 | 306,986 |
| Total | 16,095 | 2,696,117 |
| Steam: | | |
| Wood | 7,012 | 1,233,825 |
| Iron and steel | 1,451 | 2,361,593 |
| Total | 8,463 | 3,595,418 |
| Canal boats | 692 | 77,583 |
| Barges | 2,917 | 673,578 |
| Total | 3,609 | 751,161 |
| CONSTRUCTION DURING THE YEAR 1904. | | |
| *Geographical distribution.* | | |
| Atlantic and Gulf coasts | 702 | 186,680 |
| Pacific coast | 176 | 21,608 |
| Northern lakes | 119 | 159,433 |
| Western rivers | 187 | 10,821 |
| Total | 1,184 | 378,542 |
| *Power and material.* | | |
| Sail: | | |
| Wood | 326 | 49,618 |
| Steel | 4 | 15,290 |
| Steam: | | |
| Wood | 525 | 33,437 |
| Iron and steel | 88 | 222,307 |
| Canal boats | 25 | 2,753 |
| Barges: | | |
| Wood | 210 | 51,654 |
| Steel | 6 | 3,483 |
| Total | 1,184 | 378,542 |

During the years 1902 and 1903, nearly 100,000 tons of large ocean-going steamers have been added to our registered fleet.

The subject of the losses of vessels from various causes is a most important one. During the year ending June 30, 1903, 487 vessels of 107,084 gross tons were reported. The number and rig of vessels lost is shown by the annexed table:

| Rig. | Stranded. | Collision. | Fire. | Foundered. | Abandoned. | Total. |
|---|---|---|---|---|---|---|
| Steam | 21 | 8 | 49 | 28 | ..... | 106 |
| Sail | 153 | 25 | 61 | 107 | 13 | 359 |
| Unrigged | 7 | 3 | 2 | 10 | ..... | 22 |
| Total | 181 | 36 | 112 | 145 | 13 | 487 |

The very heavy percentage of loss of steamers by fire discloses unsatisfactory attention to duty in the hold or insufficient fire apparatus, or both. The table given includes lost American vessels of all sizes on the rivers and lakes of the country, as well as salt water. For comparison of the relative losses of the merchant shipping of the United States and foreign nations, the most complete figures are those of the "Bureau Veritas." They cover only sea-going steamers of over 100 gross tons and sea-going sail vessels of over 50 net tons. The proportion of foreign vessels on the ocean is so great and of American vessels so small that the figures do not clearly disclose the relative security of navigation under various flags and laws. Figures show that American sea-going vessels from 1896 to 1903 have been less liable to accident but more liable to total loss than foreign steamers, while American sea-going sail vessels have been more liable both to accident and loss than foreign sea-going sail vessels. The losses of both steamers and sail vessels of all nations are due, of course, more to stranding than to any other cause, as it accounts for 47 per cent. of the losses of American sea-going steamers and 53 per cent. of the losses of American sea-going sail vessels. The losses of foreign steamers are 44 per cent., and the losses of foreign sail vessels 46 per cent. There is a special reason why American vessels are more liable to stranding than the vessels of other nations which conduct the world's deep-sea trade. American vessels are seldom found in midocean on long voyages. Their course is usually along our own coasts in the domestic trade, or in trade with nearby countries. The excellent lighthouse system of the American coast and care in navigation have, however, overcome liability to accident from the nature of our trade along the coasts. Collision differs totally from stranding in that, for its prevention, one must look to the navigating officers. The figures show that superior care and intelligence are possessed by the navigating officers of American steamers.

The third cause of loss and accident in the order followed by the "Bureau Veritas" is fire. The element of direct human responsibility in the case of fire is considerably greater than in cases of collision, where fog and the fault of the second party to the collision may produce disaster, and is much greater than in cases of stranding, where fog, defective charts, and an inadequately lighted coast add to the perils which stress of weather always creates. Afloat or ashore fire seems usually to be a peril to life and property, to be guarded against only by a higher degree of men's watchfulness or by better extinguishing appliances. Each vessel is separated usually by the water from every other vessel as buildings ashore are not separated, so that extra precautions should produce better results with ships than with buildings. The American steam fleet contains a considerable proportion of wooden hulls, while foreign steamers are usually steel. Still it is not pleasant to notice that while the loss of 18 per cent. of lost American steamers may be charged to fire, the loss of only 4 per cent. of lost foreign steamers is charged to this cause; that while 8 per cent. of damaged American steamers suffered from fire, only 5 per cent. of foreign vessels came from this cause; that 4 per cent. of lost American sail vessels were burned and only 2 per cent. of lost foreign sail vessels were burned. The only relieving feature of these particular figures is that the proportion of accidents from fire to American sail vessels—3 per cent. of the total—was the same as to foreign vessels. The situation disclosed may be corrected. Whether that correction should come from the under-

writers or from the Government in its legislative or executive branch is not now considered.

Collision to a great extent, and fire to a greater extent, cause loss or accident to vessels mainly through lack of skill and vigilance of the officers and crew. Except where caused by unusual storms or waves vessels founder, on the other hand, on account of structural weakness of the hull. This weakness may be inherent and the fault of the builder, or it may be due to age and inadequate repair, the fault of the owner. In rare cases a new vessel, splendidly built, may yield to the tempest. The separation of causes of loss by the "Bureau Veritas" into foundered, abandoned, and missing, while proper enough from the point of view of the statistician, is not wholly satisfactory to those required to deal with facts from the point of view of possible remedy. The three classes, foundered, abandoned, and missing, really constitute one class for remedial purposes. That class consists of vessels which, on account of defects of the hull, are lost at sea. Most of them founder. Some of them are abandoned by their crews and the ship does not actually go down before their eyes. All of these ultimately go down except the proportion kept afloat by their cargoes, such as lumber-laden schooners. This small proportion constitutes the class known as "derelicts." Leaks (defects in a vessel's bottom) cause about 2 per cent. of the accidents to American steamers and to foreign steamers. Leaks, again, cause 20 per cent. of the accidents to American sail vessels, and only 15 per cent. of the accidents to foreign sail vessels.

Stress of weather or storms accounted for 10 per cent of the accidents to American steamers, 13 per cent. of accidents to foreign steamers, 30 per cent. of accidents to American sail vessels, and 35 per cent. of accidents to foreign sail vessels. Doubtless the excellent system of weather reports and storm warning along the American coasts helps to produce this favorable showing for American vessels. The principal cause of accidents to American steamers lies in the engines and boilers to which 29 per cent. of our steamer accidents are charged, compared with 24 per cent. for foreign steamers. Collision (31 per cent.) is the principal cause of British steamer accidents; stranding (31 per cent.) of German accidents. Accidents to engines and boilers may be due to defective original construction, to inadequate repairs, or to faults of the men in charge of them. Generally speaking, American machinery holds a high place in the world's esteem, and while positive evidence is not at hand, it still seems probable that American marine engines and boilers are equal to those of foreign make. If that be so then the large proportion of accidents from engines and boilers must proceed from one or both of the other two causes mentioned. The returns of the number of men including masters required to man the documented fleet of merchant vessels and yachts of the United States report crews aggregating 135,828 men, 88,249 men being engaged on steamers, while the crews of sailing vessels number 45,030 men, and unrigged boats require 2,549 men to man them. These figures are only for the crews reported.

Returns for 1903 show that 3,086 American steam vessels, including yachts, aggregating 2,994,866 gross tons, are propelled by engines aggregating 2,369,202 indicated horsepower. The figures indicate an annual consumption of about 10,000,000 long tons of coal for fuel on these steamers, and the employment on board of about 20,000 men as firemen and trimmers. The total number of steam vessels (including motor launches) on June 30, 1903, was 8,801 of 3,459,644 gross tons, so that the figures stated cover 86 per cent. of our steam tonnage, including yachts. In the navy 207 steam vessels of 206,953 tons (displacement) are propelled by engines of 624,745 indicated horse-power.—Condensed from the Report of the U. S. Commissioner of Navigation.

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Flag Day.—Flag Day is June 14. "Old Glory" was 127 years old on June 14, 1904.

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## NATIONAL SWISS RAILWAYS.

Four of the chief railway lines in Switzerland—the Central Suisse, the Nord Est, the Union Suisse, and the Jura-Simplon—have been nationalized. There only remains the St. Gothard Company. The existing concession will be renounced 1905, and the purchase price fixed on the basis of the average returns of the 10 years preceding 1894-1904.

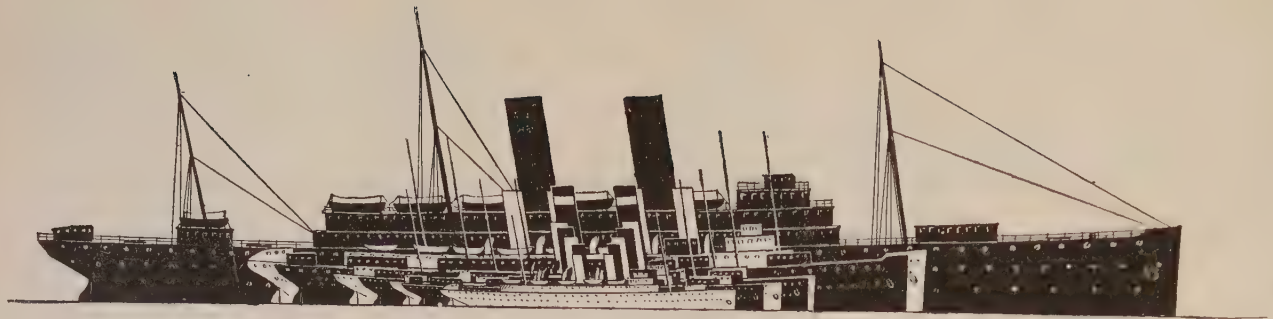
## STATEMENT OF NUMBER AND NET AND GROSS TONNAGE OF STEAM AND SAILING VESSELS OF OVER 100 TONS, OF THE SEVERAL COUNTRIES OF THE WORLD, AS RECORDED IN LLOYD'S REGISTER FOR 1904-5.

| Flag. | Steam. | | | Sail. | | Total. | |
|---|---|---|---|---|---|---|---|
| | Number. | Net Tons. | Gross Tons. | Number. | Net Tons. | Number. | Tonnage. |
| British: | | | | | | | |
| United Kingdom | 7,699 | 8,586,742 | 13,999,218 | 1,537 | 1,392,132 | 9,236 | 15,391,350 |
| Colonies | 1,088 | 516,333 | 867,309 | 926 | 322,186 | 2,014 | 1,189,495 |
| Total | 8,787 | 9,103,075 | 14,866,527 | 2,463 | 1,714,318 | 11,250 | 16,580,845 |
| American (United States): | | | | | | | |
| Sea | 880 | 869,563 | 1,311,208 | 2,090 | 1,279,141 | 2,970 | 2,590,349 |
| Lake | 386 | 846,071 | 1,129,586 | 55 | 129,465 | 441 | 1,259,051 |
| Total | 1,266 | 1,715,634 | 2,440,794 | 2,145 | 1,408,606 | 3,411 | 3,849,400 |
| Argentine | 112 | 39,758 | 64,325 | 95 | 24,474 | 207 | 88,799 |
| Austro-Hungarian | 271 | 354,392 | 569,990 | 19 | 15,166 | 290 | 585,156 |
| Belgian | 113 | 104,898 | 162,456 | 2 | 488 | 115 | 162,944 |
| Brazilian | 232 | 89,000 | 140,044 | 89 | 23,944 | 321 | 163,988 |
| Chilean | 54 | 43,376 | 69,681 | 63 | 39,204 | 117 | 108,885 |
| Chinese | 46 | 40,178 | 62,656 | ..... | ..... | 46 | 62,656 |
| Danish | 396 | 297,343 | 505,127 | 407 | 92,857 | 803 | 597,984 |
| Dutch | 394 | 403,377 | 643,529 | 102 | 44,000 | 496 | 687,529 |
| French | 755 | 639,837 | 1,252,457 | 621 | 440,909 | 1,376 | 1,693,366 |
| German | 1,483 | 1,775,928 | 2,891,869 | 452 | 477,938 | 1,935 | 3,369,807 |
| Greek | 212 | 223,020 | 350,497 | 187 | 50,721 | 399 | 401,218 |
| Italian | 368 | 460,869 | 720,209 | 870 | 467,357 | 1,238 | 1,187,566 |
| Japanese | 591 | 418,613 | 668,360 | 7 | 3,057 | 598 | 671,417 |
| Mexican | 36 | 11,101 | 18,543 | 18 | 5,274 | 54 | 23,817 |
| Norwegian | 1,038 | 620,985 | 1,017,248 | 1,180 | 700,406 | 2,218 | 1,717,654 |
| Philippine Islands | 95 | 28,380 | 45,437 | 36 | 8,132 | 131 | 53,569 |
| Portuguese | 47 | 32,617 | 51,240 | 149 | 47,761 | 196 | 99,001 |
| Russian | 650 | 375,449 | 609,622 | 720 | 230,893 | 1,370 | 840,515 |
| Spanish | 455 | 445,620 | 714,172 | 124 | 40,683 | 579 | 754,855 |
| Swedish | 785 | 327,730 | 539,481 | 732 | 212,052 | 1,517 | 751,533 |
| Turkish | 125 | 58,254 | 93,259 | 207 | 60,408 | 332 | 153,667 |
| Total, including countries not specified | 18,467 | 17,692,141 | 28,632,684 | 10,823 | 6,156,505 | 29,290 | 34,789,189 |

## THE WORLD'S LARGE AND FAST OCEAN STEAMSHIPS.

The following table shows the sea-going screw steamships in the world of 12 knots or upward, and of 2,000 gross tons or more, recorded in Lloyd's Register on July 1, 1904, including a few vessels building at that time. While in tonnage these vessels are about one-fourth of the world's sea-going steam tonnage, in efficiency, due to their size and speed, they represent more nearly one-third of the effective ocean-carrying power of the world in the general foreign and colonial carrying trade; and probably 85 per cent. of the world's foreign passenger trade.

| Speed. | 1904. | |
|---|---|---|
| | Number. | Tons. |
| Twenty knots and over | 26 | 240,371 |
| Under 20 and over 19 knots | 7 | 47,864 |
| Under 19 and over 18 knots | 17 | 137,170 |
| Under 18 and over 17 knots | 58 | 420,734 |
| Under 17 and over 16 knots | 77 | 651,865 |
| Under 16 and over 15 knots | 107 | 559,754 |
| Under 15 and over 14 knots | 161 | 809,114 |
| Under 14 and over 13 knots | 410 | 2,045,163 |
| Under 13 and over 12 knots | 540 | 2,299,115 |
| Total | 1,403 | 7,206,531 |



| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Japanese..... | 700,000 | Italian..... | 1,200,000 | Norwegian..... | 1,700,000 | German..... | 3,400,000 |
| Russian..... | 850,000 | French..... | 1,700,000 | United States..... | 2,600,000 | British..... | 16,500,000 |

COMPARATIVE MERCHANT MARINE OF THE FIRST EIGHT MARITIME NATIONS OF THE WORLD, TONNAGE EXPRESSED IN ROUND FIGURES.

The following table classifies these vessels in 1904, according to speed and flag:

| Flag. | Speed in Knots. | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | Total |
| British | 4 | 2 | 5 | 4 | .... | 9 | 27 | 37 | 46 | 84 | 208 | 322 | 748 |
| German | 4 | .... | .... | 1 | 1 | 3 | .... | 7 | 8 | 10 | 36 | 70 | 140 |
| American | .... | .... | .... | 4 | .... | 4 | 9 | 17 | 29 | 23 | 28 | 24 | 138 |
| French | .... | .... | 2 | .... | 2 | .... | 19 | 5 | 1 | 4 | 53 | 46 | 132 |
| Russian | .... | .... | .... | .... | 3 | .... | .... | 2 | 2 | .... | 5 | 22 | 34 |
| Spanish | .... | .... | .... | .... | 1 | .... | .... | 2 | 2 | 5 | 6 | 6 | 22 |
| Roumanian | .... | .... | .... | .... | .... | 1 | .... | .... | .... | .... | .... | .... | 1 |
| Japanese | .... | .... | .... | .... | .... | .... | 3 | .... | 4 | 6 | 27 | 9 | 49 |
| Danish | .... | .... | .... | .... | .... | .... | .... | 3 | .... | .... | .... | .... | 3 |
| Austro-Hungarian | .... | .... | .... | .... | .... | .... | .... | 2 | 3 | 3 | 11 | 8 | 27 |
| Italian | .... | .... | .... | .... | .... | .... | .... | 1 | 6 | 9 | 14 | 11 | 41 |
| Belgian | .... | .... | .... | .... | .... | .... | .... | 1 | 1 | .... | 10 | 2 | 14 |
| Dutch | .... | .... | .... | .... | .... | .... | .... | .... | 5 | 7 | 3 | 17 | 32 |
| Chilean | .... | .... | .... | .... | .... | .... | .... | .... | .... | 10 | .... | 1 | 11 |
| Portuguese | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | 6 | .... | 6 |
| Brazilian | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | 3 | .... | 3 |
| Argentine | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | 2 | 2 |
| Total | 8 | 2 | 7 | 9 | 7 | 17 | 58 | 77 | 107 | 161 | 410 | 540 | 1,403 |

## MOTIVE POWER AND CHIEF MATERIALS OF CONSTRUCTION OF THE WORLD'S MERCHANT MARINE.

MOTIVE POWER.

| Year | Total Vessels. | | Steam. | | | Sail. | |
|---|---|---|---|---|---|---|---|
| | Number. | Tons. | Number. | Gross Tons. | Net Tons. | Number. | Net Tons. |
| 1890 | 32,298 | 22,151,651 | 11,108 | 12,985,372 | 8,295,514 | 21,190 | 9,166,279 |
| 1895 | 30,368 | 25,107,632 | 13,256 | 16,887,971 | 10,573,642 | 17,112 | 8,219,661 |
| 1900 | 28,422 | 29,043,728 | 15,898 | 22,369,358 | 13,856,513 | 12,524 | 6,674,370 |
| 1904 | 29,290 | 34,789,189 | 18,467 | 28,632,684 | 17,692,141 | 10,823 | 6,156,505 |

Recorded in Lloyd's, 100 tons or over.

CONSTRUCTION.

| Year. | Total Vessels. | | Steam. | | Sail. | |
|---|---|---|---|---|---|---|
| | Number. | Tons. | Number. | Gross Tons. | Number. | Net Tons. |
| 1890 | 1,362 | 1,646,809 | 880 | 1,328,541 | 482 | 318,268 |
| 1895 | 794 | 1,211,615 | 629 | 1,114,019 | 165 | 97,596 |
| 1900 | 1,285 | 2,268,938 | 966 | 2,046,339 | 319 | 222,599 |
| 1903 | 1,251 | 1,979,575 | 962 | 1,847,712 | 289 | 131,863 |

Vessels built in the world (over 100 tons), according to Lloyd's (including vessels not recorded in Lloyd's).

## FOREIGN CARRYING TRADE—UNITED STATES.

The following statement of the value of imports and exports carried in United States and in foreign vessels, and the tonnage of entries and clearances from 1821 to 1904, is furnished by the Bureau of Statistics, Treasury Department:

| Fiscal Year— | Imports. | | | Exports. | | |
|---|---|---|---|---|---|---|
| | In Cars and Other Land Vehicles. | In American Vessels. | In Foreign Vessels. | In Cars and Other Land Vehicles. | In American Vessels. | In Foreign Vessels. |
| 1821 | ..... | $58,025,890 | $4,559,825 | ..... | $55,175,572 | $9,798,410 |
| 1825 | ..... | 91,902,512 | 4,437,563 | ..... | 88,799,749 | 10,735,639 |
| 1830 | ..... | 66,035,739 | 4,481,181 | ..... | 63,882,719 | 9,966,789 |
| 1835 | ..... | 135,288,865 | 14,606,877 | ..... | 94,135,191 | 27,558,386 |
| 1840 | ..... | 92,802,352 | 14,339,167 | ..... | 105,622,257 | 26,463,689 |
| 1845 | ..... | 102,438,481 | 14,816,083 | ..... | 86,942,442 | 27,704,164 |
| 1850 | ..... | 139,657,043 | 38,481,275 | ..... | 99,615,041 | 52,283,679 |
| 1855 | ..... | 202,234,900 | 59,233,620 | ..... | 203,250,562 | 71,906,284 |
| 1860 | ..... | 228,164,855 | 134,001,399 | ..... | 279,082,902 | 121,039,394 |
| 1865 | ..... | 74,385,116 | 174,170,536 | ..... | 93,017,756 | 262,839,588 |
| 1870 | ..... | 153,237,077 | 309,140,510 | ..... | 199,732 324 | 329,786,978 |
| 1875 | $13,083,859 | 157,872,726 | 382,949,568 | $7,304,376 | 156,385,066 | 501,838,949 |
| 1880 | 15,142,465 | 149,317,368 | 503,494,913 | 5,838,928 | 109,029,209 | 720,770,521 |
| 1885 | 21,149,476 | 112,864,052 | 443,513,801 | 24,183,299 | 82,001,691 | 636,004,765 |
| 1890 | 40,621,361 | 124,948,948 | 623,740,100 | 32,949,902 | 77,502,138 | 747,376,644 |
| 1895 | 33,201,988 | 108,229,615 | 590,538,362 | 49,902,754 | 62,277,581 | 695,357,830 |
| 1900 | 44,412,509 | 104,304,940 | 701,223,735 | 110,483,141 | 90,779,252 | 1,193,220,689 |
| 1904 | 68,239,120 | 132,253,065 | 790,595,186 | 152,736,889 | 97,482,054 | 1,210,608,328 |

*Note.*—The amounts carried in cars and other land vehicles were not separately stated prior to July 1, 1870. Exports are stated in mixed gold and currency values from 1862 to 1869 inclusive.

## PANAMA ROUTE.

The following table shows the distances by the proposed Panama route from some of the principal seaports of North and South America, Europe and Africa, to San Francisco and Valparaiso.

(Nautical miles.)

| From | Panama Route, San Francisco. | Panama Route, Valparaiso. | From | Panama Route. San Francisco. | Panama Route. Valparaiso. |
|---|---|---|---|---|---|
| Halifax | 5,604 | 5,210 | Hamburg | 8,423 | 7,729 |
| Portland | 5,471 | 4,781 | Bremen | 8,419 | 7,725 |
| Boston | 5,425 | 4,735 | Amsterdam | 8,202 | 7,508 |
| New York | 5,278 | 4,584 | Antwerp | 8,172 | 7,478 |
| Philadelphia | 5,267 | 4,573 | Havre | 7,959 | 7,265 |
| Baltimore | 5,320 | 4,626 | Marseilles | 8,367 | 7,673 |
| Charleston | 4,915 | 4,221 | London | 8,145 | 7,451 |
| Savannah | 4,920 | 4,226 | Liverpool | 7,907 | 7,213 |
| Key West | 4,428 | 3,744 | Glasgow | 7,890 | 7,186 |
| Pensacola | 4,696 | 4,002 | Dublin | 7,823 | 7,129 |
| Mobile | 4,723 | 4,029 | Lisbon | 7,502 | 6,813 |
| New Orleans | 4,732 | 4,038 | Gibraltar | 7,677 | 6,983 |
| Galveston | 4,833 | 4,139 | Barcelona | 8,191 | 7,497 |
| Havana | 4,365 | 3,671 | Naples | 8,663 | 7,969 |
| San Juan (P. R.) | 4,335 | 3,641 | Trieste | 9,358 | 8,664 |
| Buenos Ayres | 8,732 | 8,038 | Constantinople | 9,514 | 8,820 |
| Montevideo | 8,632 | 8,038 | Alexandria | 9,482 | 8,788 |
| Rio Janeiro | 7,642 | 6,948 | Port Said | 9,610 | 8,916 |
| St. Petersburg | 9,238 | 8,544 | Palermo | 8,605 | 7,911 |
| Stockholm | 8,940 | 8,246 | Free Town | 7,160 | 6,468 |
| Copenhagen | 8,503 | 7,809 | Cape Town | 9,760 | ..... |

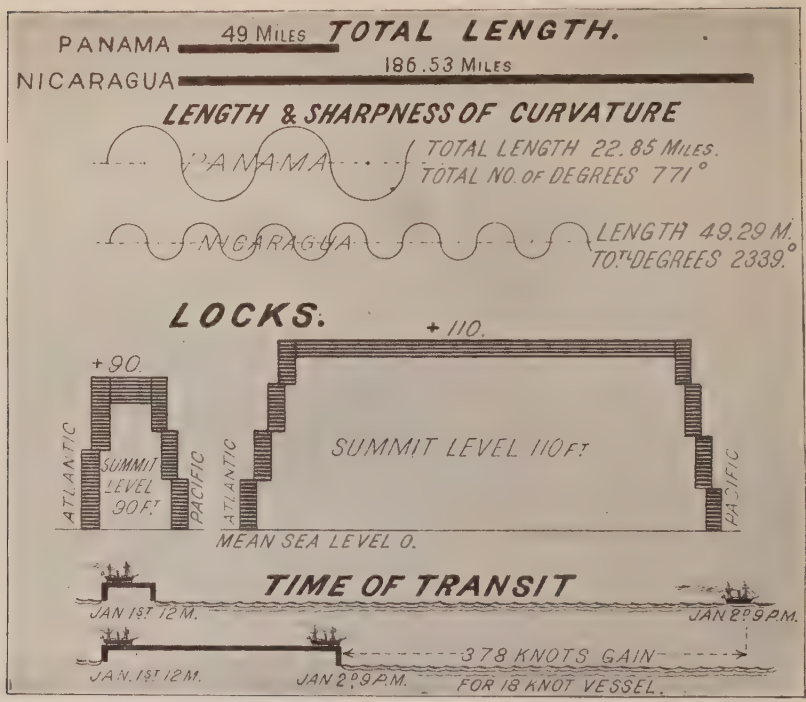



DIAGRAM SHOWING SUPERIOR ADVANTAGES OF THE PANAMA CANAL OVER THE NICARAGUA CANAL.

## PANAMA, SUEZ, AND CAPE OF GOOD HOPE ROUTES.

The following table gives the distance from New York to ports named by the routes specified:

| From | Via Panama. | Via Suez. | Via Cape of Good Hope. |
|---|---|---|---|
| New York to— | | | |
| Tientsin | 10,908 | 12,914 | 15,063 |
| Shanghai | 10,828 | 12,187 | 14,446 |
| Tokyo | 9,692 | 13,019 | 15,178 |
| Manila | 11,412 | 11,435 | 13,555 |
| Melbourne | 9,911 | 12,737 | 12,206 |

There are 47 steamships engaged in cable-laying and repairing.

The longest submarine telephone cable is on the London-Brussels route. It extends from St. Margaret's Bay to La Panne, a distance of 54 miles.

## WORLD'S OUTPUT OF TONNAGE.

| Countries. | 1903. | 1902. |
|---|---|---|
| | Tons. | Tons. |
| United Kingdom | 1,409,630 | 1,619,040 |
| Germany | 261,003 | 272,350 |
| United States | 493,144 | 314,900 |
| Holland | 71,423 | 91,120 |
| France | 107,431 | 189,930 |
| Italy | 52,380 | 49,900 |
| Norway and Sweden | 61,057 | 34,330 |
| Belgium | 17,301 | 14,560 |
| Denmark | 23,849 | 22,440 |
| Austria-Hungary | 37,208 | 20,900 |
| Russia | 63,726 | 2,740 |
| Spain and Portugal | 2,040 | 2,040 |
| Greece | 72 | 200 |
| Canada | 13,252 | 13,500 |
| Japan (European) | 35,411 | 35,570 |
| China (European) | 6,631 | 3,820 |
| Hongkong (European) | 4,309 | ..... |
| Singapore (European) | 2,379 | 3,000 |
| Other countries | 16,000 | 10,000 |

—*London Statist.*

## DIMENSIONS OF THE LARGEST FAST OCEAN STEAMERS.

The largest and in many respects the highest type of marine architecture is to be found in the modern ocean greyhound for transatlantic trade. In recent years the rival companies have vied with each other in the effort to excel, and steamships of larger size, greater speed, and more perfect equipment have followed each other, until it would seem that the limit had been reached. In the accompanying table the largest and most recent steamers are placed in comparison with the "Great Eastern."

| Name of Ship. | Date. | Length over All. | Beam. | Depth. | Draught. | Displacement. | Maximum Speed. |
|---|---|---|---|---|---|---|---|
| | | Feet. | Feet. | Feet. | Feet. | Tons. | Knots. |
| Great Eastern. | 1858 | 692 | 83 | 57½ | 25½ | 27,000 | 12 |
| Paris. | 1888 | 560 | 63 | 42 | 26½ | 13,000 | 20 |
| Teutonic | 1890 | 585 | 57½ | 42 | 26 | 12,000 | 20 |
| Campania | 1893 | 625 | 65 | 41½ | 28 | 19,000 | 22 |
| St. Paul. | 1895 | 554 | 63 | 42 | 27 | 14,000 | 21 |
| Kaiser Wilhelm der Grosse. | 1897 | 649 | 66 | 43 | 29 | 20,000 | 22.35 |
| Oceanic. | 1899 | 704 | 68 | 49 | 32½ | 28,500 | 20 |
| Deutschland. | 1900 | 686½ | 67½ | 44 | 29 | 22,000 | 23.5 |
| Baltic | 1904 | 725½ | 75 | 49 | 30½ | 40,000 | 20 |

## SPEEDS OF OCEAN GREYHOUNDS.

The following tables show the fast recorded times in which journeys have been made between English ports and those of the United States, Canada, India, China, Burmah, Australia, South Africa, and the West Indies.

| The Atlantic Record. | Line or Company. | Timing of Record Run taken between | Distance, Nautical Miles. | Record Run. | Speed, Knots per Hour. |
|---|---|---|---|---|---|
| | | | | D. H. M. | |
| Deutschland (16,500). | Hamburg-American. | New York (Sandy Hook) and Plymouth (off Eddystone). | 2,982 | E. 5 7 38 | 23.36 |
| Kronprinz Wilhelm (15,000). | North-German Lloyd. | New York (Sandy Hook) and Plymouth. | 2,978 | E. 5 8 18 | 23.21 |
| Kaiser Wilhelm II. | North-German Lloyd. | New York (Sandy Hook) and Plymouth (off Eddystone). | 3,112 | E. 5 11 58 | 23.58 |
| Lucania (12,952) | Cunard. | Queenstown (Daunt's Rock) and New York. | 2,779 | W. 5 7 23 | 21.81 |
| St. Paul (11,629) | American. | Southampton and New York. | 3,046 | W. 6 0 31 | 21.08 |
| Teutonic (10,000). | White Star. | Queenstown (Daunt's Rock) and New York. | 2,778 | W. 5 16 31 | 20.34 |
| Minneapolis (13,402). | Atlantic Transport | (Off) Dover and New York (Sandy Hook). | 3,265 | W. 8 2 31 | 16.80 |
| New England (11,400). | Dominion. | Queenstown (Daunt's Rock) and Boston Light. | 2,636 | W. 6 12 42 | 16.62 |
| Tunisian (10,576). | Allan. | Rimouski and Moville (Ireland) via Belle Isle. | 2,307 | E. 6 5 20 | 15.5 |

E. = Sailing eastward. W. = Sailing westward. —*Daily Mail Year Book*, 1905.

## RECORD OF ATLANTIC PASSENGER SERVICE TO NEW YORK.

| Year. | No. of Passages. | Cabin. | Steerage. | Total. | Year. | No. of Passages. | Cabin. | Steerage. | Total. |
|---|---|---|---|---|---|---|---|---|---|
| 1896 | 852 | 99,223 | 252,350 | 351,573 | 1900 | 838 | 137,852 | 403,491 | 541,343 |
| 1897 | 901 | 90,932 | 192,004 | 382,936 | 1901 | 887 | 128,143 | 438,868 | 567,011 |
| 1898 | 812 | 80,586 | 219,651 | 300,237 | 1902 | 922 | 139,848 | 574,276 | 714,124 |
| 1899 | 826 | 107,415 | 303,762 | 411,177 | 1903 | 969 | 161,438 | 643,358 | 804,796 |

—*Daily Mail Year Book*, 1905

## RETURN OF PASSENGERS LANDED AT NEW YORK BY SEVEN PRINCIPAL LINES.

| Line. | 1903. | | 1902. | | 1900. | |
|---|---|---|---|---|---|---|
| | Cabin. | Steerage. | Cabin. | Steerage. | Cabin. | Steerage. |
| North-German Lloyd | 36,031 | 119,079 | 27,767 | 110,697 | 26,577 | 92,143 |
| Hamburg-American | 23,965 | 114,458 | 20,698 | 98,988 | 23,657 | 72,245 |
| White Star | 22,418 | 45,705 | 18,402 | 40,225 | 14,948 | 29,370 |
| Cunard | 18,522 | 32,957 | 16,308 | 23,650 | 20,000 | 22,751 |
| French | 11,502 | 51,454 | 8,634 | 49,498 | | |
| American | 10,560 | 16,081 | 14,456 | 20,658 | 16,435 | 16,884 |
| Red Star | 8,966 | 54,726 | 6,878 | 47,119 | | |

—*Daily Mail Year Book*, 1905.

## FIRST STEAMBOATS, PIONEER SAILINGS, AND EARLIEST LINES.

1707. Denis Papin experimented on River Fulda with paddle-wheel steamboat.

1736. Jonathan Hulls patented designs similar to modern paddle boat.

1769. James Watt invented a double-acting side-lever engine.

1783. Marquess of Jouffrey made experiments in France.

1785. James Ramsey, in America, propelled a boat with steam through a stern-pipe.

1785 Robert Fitch, in America, propelled a boat with canoe-paddles fixed to a moving beam.

1787. Robert Miller, of Edinburgh, tried primitive manual machinery.

1788. Miller, with Symington, produced a double-hull stern-wheel steamboat.

1802. *Charlotte Dundas*, the first practical steam tugboat, designed by Symington.

1804. *Phœnix*, screw-boat designed by Stephens in New York; first steamer to make a sea voyage.

1807. *Clermont*, first passenger steamer continuously employed; built by Fulton in U. S.A.

1812. *Comet*, first passenger steamer continuously employed in Europe; built by Miller in Scotland.

1818. *Rob Roy*, first sea-trading steamer in the world, built at Glasgow.

1819. *Savannah*, first auxiliary steamer, paddle wheels, to cross the Atlantic; built in New York.

1821. *Aaron Manby*, first steamer (English canal boat) built of iron.

1823. City of Dublin Steam Packet Co. was established.

1824. General Steam Navigation Co. was established at London.

1824. George Thompson & Co. (Aberdeen Line), were established.

1825. *Enterprise* made the first steam passage to India.

1825. *William Fawcett*, pioneer steamer of the P. & O. S. N. Co.

1830. T. & J. Harrison (Harrison Line) were established at Liverpool.

1832. *Elburkah*, iron steamer, took a private exploring party up the Niger.

1834. Lloyd's Register for British and Foreign Shipping established.

1836. Austrian Lloyd Steam Navigation Co. established at Trieste.

1837. *Francis B. Ogden*, first successful screw tugboat; fitted with Ericsson's propeller.

1838. *Archimedes*, made the Dover-Calais passage under two hours, fitted with Smith's propeller.

1838. *R. F. Stockton*, built for a tugboat, fitted with Ericsson's propeller, sailed to America; first iron vessel to cross the Atlantic; first screw steamer used in America.

1839. *Thames*, pioneer steamer of the Royal Mail Steam Packet Co.

1839. George Smith & Sons (City Line) were established at Glasgow.

1840. *Britannia*, pioneer steamer of the Cunard Line.

1840. *Chile*, pioneer steamer of the Pacific Steam Navigation Co.

1845. *Great Britain*, first iron screw steamer, precursor of modern Atlantic steamer.

1845. Thos. Wilson, Sons & Co., Ltd. (Wilson Line), established at Hull.

1847. Pacific Mail Steamship Co. established in America.

1849. Houlder Brothers & Co. established at London.

1850. Bullard, King & Co. (Natal Line) established at London.

1850. Messageries Maritimes de France established.

1850. Inman (now American) Line, established at Liverpool.

1851. *Tiber*, first steamer of the Bibby Line, established 1821 at Liverpool.

1852. *Forerunner*, pioneer steamer of the African Steamship Co.

1853. Union Steamship Co. was established (now Union-Castle Line.)

1853. *Borussia*, first steamer of the Hamburg-American Packet Co., established 1847.

1854. *Canadian*, first steamer of the Allan Line, established 1820.

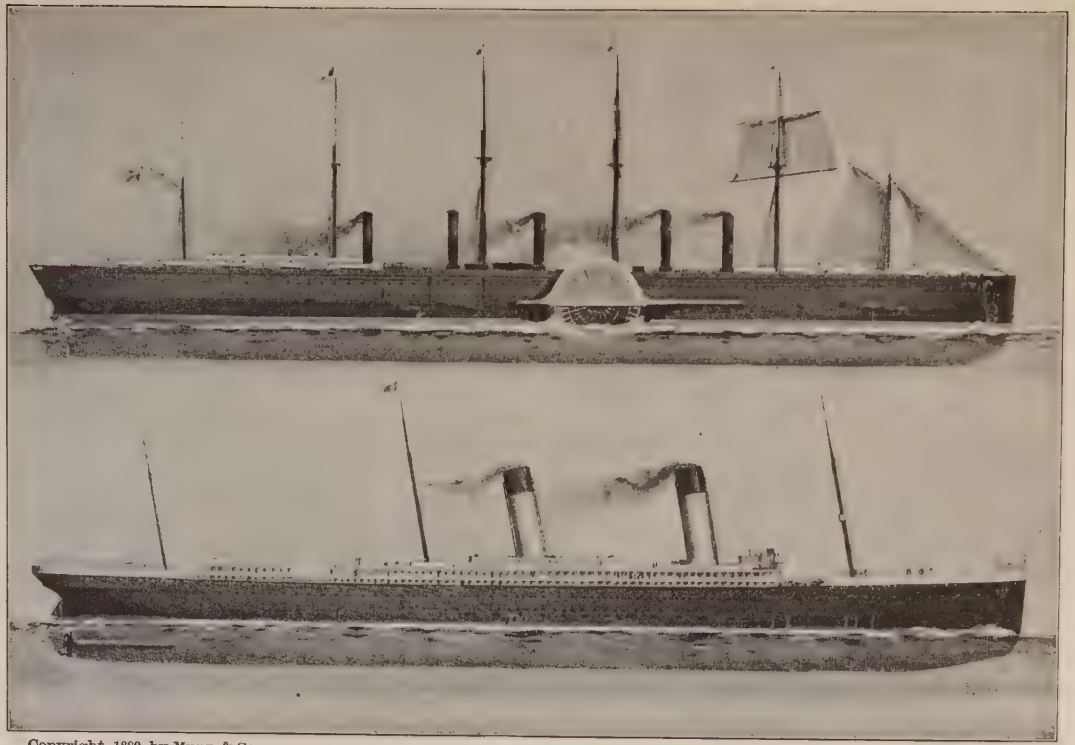
1855. British India Steam Navigation Co. was established.

1856. *Tempest*, first steamer Anchor Line.

1858. *Bremen*, first Atlantic steamer of the Norddeutscher Lloyd, established 1856.

1858. *Great Eastern* launched into the Thames. Jan. 31; commenced, May 1, 1854.

—*Whittaker's Almanac.*



Copyright, 1899, by Munn & Co.

"Great Eastern"—Length over all, 692 ft.; beam, 83 ft.; depth, 57½ ft.; displacement on 25½ ft draught, 27,600 tons; horse power, 8,000; maximum speed, 14½ knots.
"Oceanic" " " " 704 " " 68 " " 49 " " " 32½ " " 28,500 " " " 28,000; " " 21¼ "

"GREAT EASTERN" AND "OCEANIC" COMPARED.

## NUMBER OF VESSELS OVER 5,000 TONS EACH, AND PARTICULARS OF LARGEST VESSELS BELONGING TO EACH COUNTRY.

| Country. | No. | Ship's Name. | Gr. Tons. | Speed. | Owners. |
|---|---|---|---|---|---|
| Austria | 8 | Austria | 7,588 | 12½ | Austrian Lloyd. |
| Belgium | 2 | Vaderland | 12,018 | 16 | Red Star Line. |
| Brazil | — | Rio Gallejos | 2,987 | * | Hamburg S. American SS. Co. |
| Chile | 1 | Rancajua | 5,975 | * | S. American Nav. Co. |
| Denmark | 5 | United States | 10,100 | 16 | Forende Dampskibs, Copenhagen. |
| France | 52 | La Savoie | 11,884 | 21 | Compagnie Gén. Transatlantique. |
| Germany | 140 | Kaiser Wilhelm II. | 19,360 | 23½ | Norddeutscher Lloyd. |
| Gr. Britain | 464 | Baltic | 23,876 | 17 | White Star Line. |
| Greece | — | Keramiai | 4,702 | * | M. S. Vagliano. |
| Holland | 13 | Noordam | 12,531 | 15 | Holland-American Line. |
| Italy | 9 | Pallanza | 6,669 | * | Cantière Navale di Muggiano. |
| Japan | 24 | Aki Maru | 6,444 | 14 | Nippon Yusen Kaisha. |
| Norway | — | Admiral Borrsen | 4,060 | * | W. Forkildsen. |
| Russia | 12 | Franche Comte | 7,078 | 20 | Russian Vol. Fleet Assn. |
| Spain | 7 | Alfonso XII | 6,875 | 19 | Compañia Transatlantica. |
| Sweden | 2 | Kronprins Gustaf | 5,383 | * | A. Johnson. |
| UnitedStates | 62 | Minnesota | 20,718 | 15 | Gt. Northern Steamship Co. |
| Total | 800 | | | | * Under 12 Knots. |

## FROM STEAM PACKET TO STEAM PALACE.

(1) Wood Paddle-boats. (3) Iron Screw Steamers. (5) Steel Twin-Screw Steamers.
(2) Iron " (4) Steel " "

| Date | Name of Steamer. | Owners. | Remarks. |
|---|---|---|---|
| 1833 | Royal William (1) | Quebec & Halifax S.N.Co. | From Pictou (N.S.), 1st to cross the Atlantic. |
| 1838 | Sirius | British and Amer. S.N.Co. | From Cork, 1st departure from U. K. |
| " | Great Western | Great Western S.N.Co. | " Bristol, 1st built for Atlantic. |
| " | Royal William (2) | Transatlantic SS. Co. | " Liverpool, 1st departure. |
| 1840 | Britannia | Cunard Line | " Liverpool, 1st carried British mails. |
| 1849 | Atlantic | Collins " | " New York, 1st carried U.S. mails. |
| 1854 | Canadian | Allan " | " Glasgow, 1st steamer of Line. |
| 1856 | Tempest | Anchor " | " " 1st " " |
| " | Borussia | Hamburg-American Line | " Hamburg, 1st " " |
| " | Adriatic | Collins Line | Last Sailing of Line. |
| 1858 | Bremen | Norddeutscher Lloyd | From Bremen to New York. |
| 1856 | Persia (2) | Cunard | 1st Cunard iron paddle steamer. |
| 1862 | Scotia | " | Last " " " " |
| 1845 | Great Britain (3) | Great Western S.N.Co. | 1st Atlantic iron screw steamer. |
| 1850 | City of Glasgow | Inman Line | 1st to carry steerage passengers. |
| 1858 | Great Eastern | East. and Australian SS.Co. | Paddle wheels and propeller. |
| 1868 | Italy | National Line | 1st Atlantic ss. with comp. engines. |
| 1869 | City of Brussels | Inman " | 1st " " " steam steering gear. |
| 1871 | Oceanic (1st) | White Star Line | 1st with midship saloon, &c. |
| 1873 | Pennsylvania | American " | 1st sailing of Line to Liverpool. |
| 1874 | Britannic | White Star " | 1st to exceed 5,000 tons, Great Eastern |
| 1875 | City of Berlin | Inman " | 1st with electric light. [excepted. |
| 1879 | Arizona | Guion " | Watertight compartments floated her. |
| 1882 | Alaska | " " | 1st "ocean greyhound." |
| 1883 | Oregon | " (1) / Cunard " (2) | Sunk outside New York; every one saved by N. D. Lloyd ss. Fulda. |
| 1879 | Buenos Ayrean (4) | Allan Line | 1st Atlantic steel steamer.* |
| 1881 | Servia | Cunard " | 1st Cunard " " |
| " | City of Rome | Inman (1) Line / Anchor (2) " | Fitted with three funnels. |
| 1884 | America | National " | 1st and last express ss. of Line. |
| " | Umbria / Etruria | Cunard " | 1st with 20 knots speed. |
| 1886 | Aller | Norddeutscher Lloyd | 1st triple-expansion express ss.† |
| 1888 | City of New York (5) / City of Paris | Inman & International (1) / American Line (2) | 1st twin-screw ocean expresses.‡ 1st to exceed 10,000 tons, G.E. excepted |
| 1889 | Teutonic / Majestic | White Star Line | Designed as mercantile cruisers. |
| 1890 | Fürst Bismarck | Hamburg-American Line | 1st under 6½ days from Southampton. |
| 1892 | La Touraine | Compagnie Générale Trans. | Record Havre to New York, 6¼ days. |

## FROM STEAM PACKET TO STEAM PALACE—*Continued.*

| Date | Name of Steamer. | Owners. | Remarks. |
|---|---|---|---|
| 1893 | Campania | Cunard Line | Lucania: highest day's run 562 knots. |
| | Lucania | | Liverpool to New York records. |
| 1895 | St. Paul | American | Largest express steamers ever built in America. |
| | St. Louis | | |
| 1897 | Kaiser Wilhelm d. Gr. | Norddeutscher Lloyd | Record day's run, 580 knots. [tons. |
| 1899 | Oceanic | White Star Line | Balanced engines. 1st to exceed 15,000 |
| 1900 | Deutschland | Hamburg-American Line | Fastest ocean steamer in the world. |
| 1901 | Celtic | White Star Line | 1st to exceed 20,000 tons. |
| 1902 | Kronprinz Wilhelm | Norddeutscher Lloyd | |
| 1903 | Kaiser Wilhelm II | Norddeutscher Lloyd | Largest express steamer in the world. |
| 1904 | Baltic | White Star Line | Largest ss. in the world—726x76x49. |

* Union Co. of N.Z.'s Rotomohana, 1,763 tons, was first ocean steel ss. 1879.
† Martello, 2,432 tons, of Wilson Line, was first Atlantic cargo triple-expansion ss. 1884.
‡ Notting Hill, 3,921 tons, of Twin-screw Cargo Line, came out so engined, 1881.

### REDUCTION OF PASSAGE.

| | Days. | | | Tons. |
|---|---|---|---|---|
| 1862. | Under 9 | from Q'town, | Scotia | 3,871 |
| 1869. | " 8 | " | City of Bruss' | 3,081 |
| 1882. | " 7 | " | Alaska | 6,400 |
| 1889. | " 6 | " | City of Paris | 10,669 |
| 1894. | " 5½ | " | Lucania | 12,950 |
| 1897. | " 6 | " S'ton. | Kaiser Wilhelm der Gr | 14,349 |
| 1903. | " 5½ | " Cherb'g | Deutschland | 16,502 |

### PROGRESS IN LENGTH.

| | | Feet. | | Tons. |
|---|---|---|---|---|
| 1838, | 1st to exceed | 200 | Great Western | 1,340 |
| 1845 | " " | 300 | Great Britain | 2,084 |
| 1858 | " " | 680 | Great Eastern | 18,918 |
| 1871 | " " | 400 | Oceanic (1). . | 3,807 |
| 1881 | " " | 500 | Servia | 7,392 |
| 1893 | " " | 600 | Campania | 12,952 |
| 1899 | " " | 700 | Oceanic (2). . | 17,247 |
| 1904 | " " | 725 | Baltic | 23,000 |

## LARGEST STEAMSHIP OWNERS IN THE WORLD.

Owners of over 100,000 gross tons in order of tonnage.

| Lines. | Head Office. | Total Tonnage. | Over 20 knots. | Knots. 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | Under 12 knots. | Total. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Hamburg-American | Hamburg | 705,000 | 1 | .. | 1 | 1 | .. | 3 | 1 | .. | 7 | 29 | 96 | 139 |
| Norddeutscher Lloyd | Bremen | 559,000 | 3 | .. | .. | .. | 1 | 7 | 7 | 9 | 21 | 18 | 50 | 116 |
| British India Steam N. Co. | London | 443,000 | .. | .. | .. | .. | 2 | 5 | 21 | 25 | 23 | 38 | 9 | 123 |
| P. & O. Steam N. Co. | London | 367,000 | .. | 2 | .. | 12 | 4 | 6 | .. | 9 | 11 | 11 | 4 | 59 |
| White Star | Liverpool | 354,000 | 1 | 2 | .. | .. | 3 | 3 | 3 | .. | 1 | 8 | 9 | 30 |
| Union-Castle | London | 302,000 | .. | .. | .. | .. | 10 | 2 | .. | 3 | 4 | 19 | 8 | 46 |
| Elder, Dempster & Co. | Liverpool | 269,000 | .. | .. | .. | .. | 2 | 2 | 2 | .. | 13 | 6 | 73 | 95 |
| Messageries Maritimes | Paris | 269,000 | .. | .. | .. | .. | 10 | 4 | .. | 1 | 26 | 9 | 24 | 64 |
| A. Holt | Liverpool | 267,000 | .. | .. | .. | .. | .. | .. | .. | 3 | 27 | 16 | 7 | 53 |
| Ellerman Lines, Ltd | Liverpool | 250,000 | .. | .. | .. | .. | .. | .. | .. | 2 | 6 | 13 | 54 | 75 |
| Nippon Yusen Kaisha | Tokio | 248,000 | .. | .. | .. | .. | .. | .. | 3 | 7 | 23 | 4 | 41 | 78 |
| Leyland | Liverpool | 239,000 | .. | .. | .. | .. | .. | .. | .. | 6 | 9 | 18 | 9 | 42 |
| Navigazione Gen. Italiana | Rome | 231,000 | .. | .. | .. | .. | .. | 4 | 6 | 4 | 17 | 12 | 64 | 107 |
| Clan | Glasgow | 216,000 | .. | .. | .. | .. | .. | .. | .. | .. | 4 | 24 | 26 | 54 |
| Hansa | Bremen | 209,000 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 50 | 50 |
| Austrian Lloyd | Trieste | 203,000 | .. | .. | .. | .. | .. | 3 | 3 | 3 | 11 | 13 | 36 | 69 |
| Wilson | Hull | 196,000 | .. | .. | .. | .. | .. | .. | .. | .. | 15 | 8 | 76 | 99 |
| Cunard | Liverpool | 191,000 | 2 | 2 | .. | .. | 1 | 2 | 1 | 3 | 1 | .. | 10 | 22 |
| Harrison | Liverpool | 186,000 | .. | .. | .. | .. | .. | .. | .. | .. | 23 | 10 | 5 | 38 |
| Compagnie Géné. Trans. | Paris | 182,000 | 2 | .. | 2 | .. | 9 | 1 | 6 | 7 | 4 | 6 | 19 | 56 |
| American | Philadelphia | 171,000 | 4 | .. | .. | .. | .. | 4 | 1 | 5 | 3 | 2 | 2 | 21 |
| Chargeurs Réunis | Paris | 162,000 | .. | .. | .. | .. | .. | .. | .. | .. | 13 | 26 | 2 | 41 |
| Pacific Steam N. Co. | Liverpool | 151,000 | .. | .. | .. | .. | 1 | 1 | 16 | 8 | 4 | 7 | 6 | 43 |
| Lamport & Holt | Liverpool | 148,000 | .. | .. | .. | .. | .. | .. | .. | 2 | 1 | 14 | 12 | 29 |
| Canadian Pacific Railway | Montreal | 144,000 | .. | .. | 1 | .. | .. | 3 | 2 | 2 | 5 | 9 | 19 | 41 |
| Forenede Dampsk. Selskab. | Copenhagen | 143,000 | .. | .. | .. | .. | .. | 3 | 1 | 3 | 1 | 2 | 109 | 119 |
| Atlantic Transport Co. | London | 138,000 | .. | .. | .. | .. | .. | 3 | 1 | 3 | .. | .. | 12 | 19 |
| Allan | Glasgow | 135,000 | .. | .. | .. | 2 | .. | 2 | 1 | 1 | 4 | 6 | 13 | 29 |
| Anchor | Glasgow | 135,000 | .. | .. | .. | .. | .. | 1 | .. | 3 | 4 | 5 | 16 | 30 |
| Hamburg South American | Hamburg | 132,000 | .. | .. | .. | .. | .. | .. | .. | .. | 5 | 6 | 19 | 30 |
| Deutsch-Australische | Hamburg | 115,000 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 25 | 25 |
| Pacific Mail | San Francisco | 113,000 | .. | .. | .. | 2 | 1 | 3 | .. | 3 | 2 | .. | 11 | 21 |
| Prince | Newcastle-on-T. | 113,000 | .. | .. | .. | .. | .. | .. | 2 | .. | .. | 9 | 30 | 41 |
| Kosmos | Hamburg | 109,000 | .. | .. | .. | .. | .. | .. | .. | .. | .. | 11 | 17 | 28 |
| Royal Mail S. P. Co | London | 108,000 | .. | .. | .. | .. | .. | 2 | 6 | 2 | .. | 4 | 20 | 34 |
| R. Ropner & Co. | West Hartlepool | 106,000 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 37 | 37 |
| Russian Steam N. & T. Co. | St. Petersburg | 104,000 | .. | .. | .. | .. | .. | .. | .. | .. | .. | 17 | 52 | 69 |
| Bucknall | London | 102,000 | .. | .. | .. | .. | .. | .. | .. | .. | 3 | 12 | 15 | 30 |
| Shell | London | 100,000 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 35 | 35 |

—*Whitaker's Almanack*, 1905.

## OCEAN STEAMERS. 16 Knots and over.

| Country. | 20 knots & above. | 19 knots. | 18½ kts. | 18 knots. | 17½ knots. | 17 kts. | 16 knots. | Total. |
|---|---|---|---|---|---|---|---|---|
| Austria | .. | .. | .. | .. | .. | .. | 2 | 2 |
| Belgium | .. | .. | .. | .. | .. | .. | 1 | 1 |
| France | .. | 2 | .. | .. | 12 | 7 | .. | 21 |
| Denmark | .. | .. | .. | .. | .. | .. | 3 | 3 |
| Germany | 5 | 1 | 2 | 1 | .. | .. | 5 | 14 |
| Great Britain | 9 | 1 | .. | 9 | 16 | 11 | 37 | 83* |
| Italy | .. | .. | .. | .. | .. | .. | 4 | 4 |
| Japan | .. | .. | .. | .. | .. | 3 | .. | 3 |
| Russia | .. | 3 | .. | .. | .. | .. | 2 | 5 |
| Spain | .. | 1 | .. | .. | .. | .. | 2 | 3 |
| United States | 5 | .. | 1 | 4 | 3 | 12 | 19 | 44 |
| | 19 | 8 | 3 | 14 | 31 | 33 | 75 | 183 |

*P. & O., 22; R. Mail, 2; Union-Castle, 12; White Star, 10; Cunard, 7; Pacific S. N. Co., 2; Orient, 5; Atlantic Transport Co., 3; Dominion, 3; Elder, Dempster, 4; Canadian Pac. Rail., 4; Union of N. Zealand, 4; Allan, 4; Khedivial Mail Co., 2; Anchor, 1; International Nav. Co., 1. N.B.—There were on June 30, 1904, only 1,627 ocean steamers in the world capable of a sea-speed of at least 12 knots per hour, of which 805 were British. See article on "Baltic" on page 32.

## OCEAN STEAMERS. 20 Knots and over. In order of Tonnage.

| Built in | Names. | Owners. | Gross Tons. | Dimensions. | Spd. | Builders. |
|---|---|---|---|---|---|---|
| 1902 | Kaiser Wilhelm II | N.D. Lloyd. | 19,360 | 678x72x38 | 23½ | StettinV.Co. |
| 1899 | Oceanic | White Star. | 17,274 | 685x68x44 | 21 | Harland&W. |
| 1900 | Deutschland | Hamburg-American | 16,502 | 662x67x40 | 23½ | Stettin V. Co. |
| 1901 | Kronprinz Wilhelm | N. D. Lloyd | 14,908 | 640x66x43 | 23 | " |
| 1897 | Kaiser Wilhelm der Grosse | " | 14,349 | 627x66x35 | 22½ | " |
| 1893 | Campania | Cunard. | 12,950 | 601x65x37 | 22 | Fairfield. |
| 1893 | Lucania | " | 12,950 | | | |
| 1897 | Kaiser Friedrich | F. Schichau. | 12,480 | 581x63x44 | 22 | Schichau. |
| 1900 | La Lorraine | Com. Gén. Trans. | 11,869 | 563x60x35 | 20 | Owners. |
| 1900 | La Savoie | | | | | |
| 1895 | St. Louis | International Mer- | 11,864 | 535x63x37 | 21 | Cramp&Sons. |
| 1895 | St. Paul | cantile Marine. Co. | 11,629 | | | |
| 1888 | New York | " | 10,798 | 527x63x22 | 20 | Clydebank. |
| 1889 | Philadelphia (ex Paris) | " | 10,786 | | | |
| 1890 | Majestic | White Star | 10,147 | 565x58x39 | 20 | Harland&W. |
| 1889 | Teutonic | " | 9,984 | | | |
| 1890 | Kaiserin Maria Theresa | N. D. Lloyd. | 8,278 | 528x51x36 | 20 | Stettin V.Co. |
| 1884 | Umbria | Cunard. | 8,128 | 501x57x38 | 20 | Fairfield. |
| 1884 | Etruria | " | 8,120 | | | |
| 1898 | Moskva | Russ. Vol.Flt.Assoc. | 7,297 | 487x58x26 | 20 | Clydebank. |
| 1898 | Smolensk | " " | 7,270 | | | |
| 1898 | Isis | P. & O. | 1,728 | 300x37x17 | 20 | Caird & Co. |
| 1898 | Osiris | | | | | |

## SHORT TRIP STEAMERS (British and Foreign). 20 Knots and over

| British Boats. | | Owners. |
|---|---|---|
| *Connaught, Leinster, Munster, Ulster, all 23½ knots | 4 | City of Dublin Steam Packet Co. |
| Empress Queen 22, Pr. of Wales 21, Queen Victoria 21 | 3 | Isle of Man Steam Packet Co. |
| France 21½, Sussex, Tamise, Manche, all 21½, Arundel | 5 | London B. & S. C. Railway. |
| Brighton † | 1 | London B. & S. C. Railway. |
| Banshee 21, Cambria, Anglia, Hibernia, Scotia | 5 | London & North-Western Railway. |
| Antrim, Donegal, Londonderry, † Manxman † | 4 | Midland Railway. |
| Brighton Queen, Britannia, Cambria, Westward Ho | 4 | P. A. Campbell, Ltd. |
| King Edward,† Queen Alexandria | 2 | John Williamson. |
| Royal Sovereign | 1 | Fairfield S. & E. Co., Ltd. |
| La Marguerite | 1 | Liverpool & NorthWales SS.Co.,Ltd. |
| Princess Maud † | 1 | Portpatrick&Wigtownshire Railway |
| The Queen † | 1 | South-Eastern & Chatham Railway |
| Total | 32 | |

| Foreign Boats. | | |
|---|---|---|
| Belgian Government; 3, 22 kts.; 3, 21 kts. | 6 | Dover—Ostend Service. |
| Cie. des Chemins de Fer du Nord of France | 2 | Dover—Calais Service. |
| Zeeland Steamship Co. of Holland | 3 | Queensborough—Flushing Service. |
| Central Railroad Co., New Jersey, U. S. | 1 | New York—The Highlands. |
| Total | 12 | |

*The four fastest short-trip steamers in the world. †Turbine engines. —*Whitaker's Almanack.*

Length, 725 feet 9 inches. Beam, 75 feet. Maximum Displacement, 40,000 tons.

THE NEW TRANSATLANTIC STEAMSHIP "BALTIC" THE LARGEST VESSEL AFLOAT.

## THE NEW WHITE STAR LINER "BALTIC"—THE LARGEST VESSEL IN THE WORLD.

THE FOUR UPPER DECKS OF THE "BALTIC."

The success of the "Oceanic" showed that the most remunerative type of craft for the transatlantic traffic is the vessel of a medium speed, maintained under all varying conditions, but of a tremendous tonnage. Although speed may be an important desideratum from one point of view, such a qualification is in reality only appealing to a limited quota of passengers, the bulk of travelers preferring greater comfort and steadiness of the vessel, especially in rough weather. Each of the two vessels built after the "Oceanic" has marked an increase in size and tonnage upon its predecessor.

The latest liner, the "Baltic," surpasses in size anything that has thus far been attempted, though it is by no means the finite, for Messrs. Harland & Wolff have declared their readiness to build a vessel of 50,000 tons. The realization of such a vessel is dependent upon the capacity of a dock to accommodate it.

The length of the "Baltic" over all is 725 feet 9 inches. This is an increase upon the length of the "Celtic" and "Cedric" of 25 feet. The beam is the same, being 75 feet; the depth, 49 feet. The gross tonnage is 23,000 tons, an increase of about 3,000 tons. The cargo capacity is about 28,000 tons, and the total displacement at the load draft approximates 40,000 tons.

The total complement of passengers is 3,000 passengers, and a crew of about 350. The general arrangement of the ship is similar to the other two vessels of this type—a continuous shade deck running fore and aft, with three tiers of deckhouses and two promenade decks above same. On the upper promenade deck is the first-class smokeroom and library, and the two houses below contain the deck staterooms. All the first-class accommodation is situated amidships.

The vessel is not speedy. In the case of the "Oceanic" a speed of 20 knots can be maintained, but in the subsequent vessels this was reduced to about 16½ knots. The "Baltic" will approximate the same speed, with a great reserve of power, to enable this rate of traveling to be maintained even under adverse conditions.

The "Baltic" is fitted with engines of Harland & Wolff's quadruple-expansion type, developing about 13,000 I. H. P. The engines are arranged on the balance principle, which practically does away with all vibration. The twin engines and twin screws afford another element of safety to the ship and passengers, and the possibility of danger is reduced to a minimum.

The maiden trip of the "Baltic" was made without incident. Her trip occupied 7 days 13 hours and 37 minutes. She left Liverpool at 5 P. M. on June 29, 1904, and by 8:21 had passed Rock Light on her way to Queenstown. Her daily runs were: July 1, 312 knots; July 2, 395 knots; July 3, 403 knots; July 4, 417 knots; July 5, 387 knots; July 6, 407 knots; July 7, 414 knots.

The engines ran from seventy-eight to eighty revolutions a minute, while the forty-eight furnaces consumed only 235 tons of coal a day. Her engine and fireroom force is comparatively small—fourteen engineers, fifteen oilers, thirty-six firemen, twenty-six coal passers, two storekeepers, two stewards and one winchman making up the three watches.

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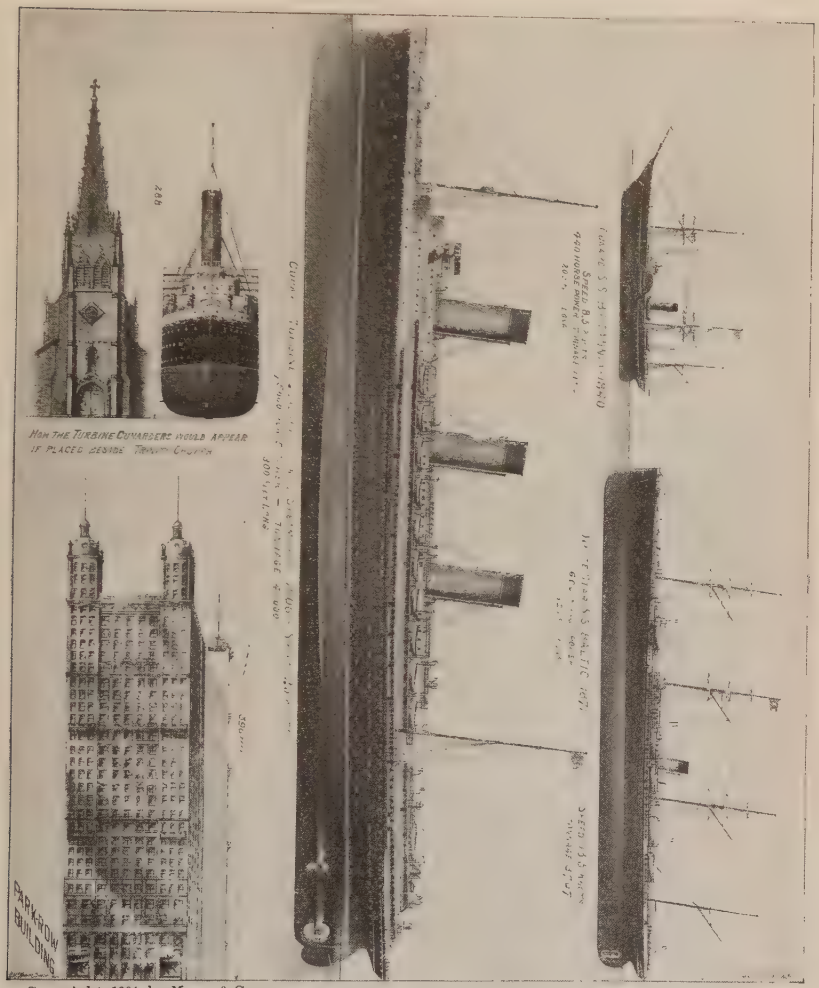
Electricity on Shipboard.—Among the later developments of electricity is that on shipboard. The most complete installation of this kind is that on the "Kronprinz Wilhelm." Here all the cabins have telephones, in addition to the electric light, and call bells. The first-class cabins and the dining-room are heated by electric stoves. A system of bulkhead telegraphy enables the captain in a moment of danger, caused by collision, to see, while on the bridge, whether all the water-tight doors are closed. There are forty such doors, and each one falls into place.

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THE QUADRUPLE SCREW TURBINE CUNARDERS OF 1906 COMPARED WITH THE PARK ROW BUILDING, TRINITY CHURCH, THE WHITE STAR STEAMSHIP "BALTIC" OF 1871, AND THE FIRST CUNARD STEAMSHIP "BRITANNIA" OF 1840.

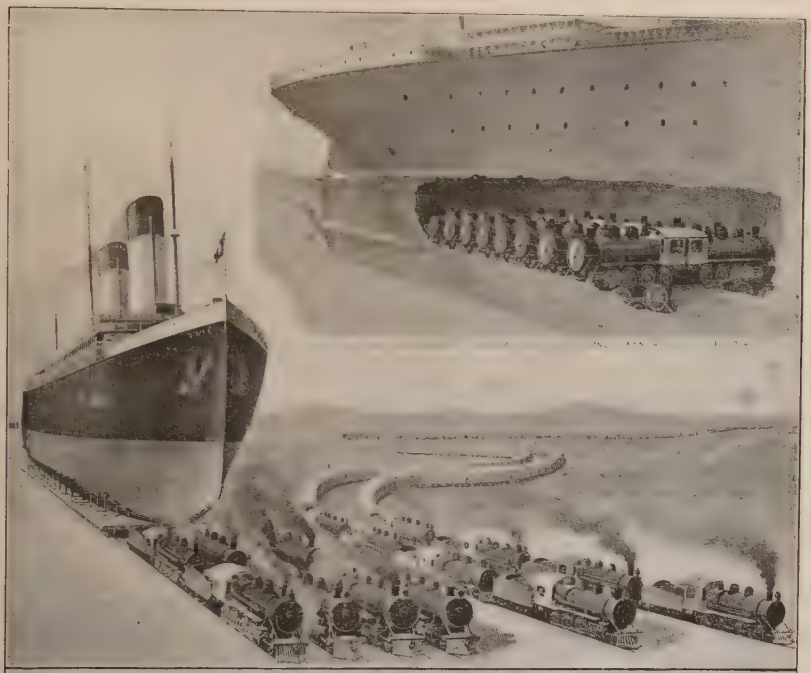
## AMERICAN FREIGHT LOCOMOTIVES AND THE ENGINES OF THE "OCEANIC"—A COMPARISON OF HORSEPOWER.

We are told that "Comparisons are odious," and the statement would seem to be based upon a fairly correct estimate of human nature; but as soon as we get outside of the range of human susceptibilities and apply our comparisons to insensate things, comparisons become not only extremely interesting, but at times a valuable means of increasing our general knowledge and our sense of the proper relative proportion of things.

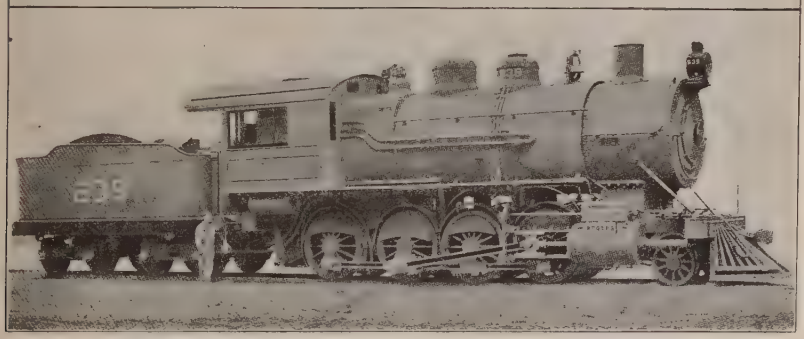
The pictorial comparison to be found here is based upon one of the mammoth freight locomotives which are being turned out in considerable numbers just now by the leading locomotive works of the country. In addition to the usual information as to dimensions and construction, Mr. R. Wells, the superintendent of the Rogers Locomotive Works, has favored us with particulars of some novel experiments which he carried out to determine the exact location of the center of gravity of this locomotive above the rails. He has also given us particulars of its horsepower and freight-hauling capacity on a level road, and it occurs to us that a comparison of the relative power of one of these engines when working up to its maximum indicated horsepower with the maximum indicated horsepower of the "Oceanic," the second largest steamship in the world, will be attractive to that section of our readers that likes to have its facts enlivened occasionally with a touch of the fanciful and curious.

The locomotive shown is an extremely powerful Consolidation which was recently built by the Rogers Company for the Illinois Central Railroad for use on one of the divisions of their line where the grades are somewhat heavier than on the divisions connecting with it. It was designed to haul trains of a maximum weight of 2,000 tons over grades of 38 feet to the mile. The cylinders are 23 inches in diameter, by 30 inches stroke; the drivers are 57 inches in diameter and they carry 198,000 pounds weight of the locomotive out of a total weight of 218,000 pounds. The boiler, which is of the Belpaire type, is 80 inches in diameter at the smoke-box; the fire-box measures 42 inches by 132 inches, and there are 417 2-inch tubes which are 13 feet 8 inches in length. There are 252 square feet of heating surface in the fire-box, and 2,951 square feet in the tubes, making a total heating surface of 3,203 square feet. The tender is exceptionally large, the capacity of the tank being 5,000 gallons, while the coal space has a capacity of 10 tons.

The increase in the diameter of locomotive boilers which has taken place of late years has necessitated their being carried above the tops of the wheels, with the result that the center of the boiler is in some recent locomotives as much as 9 feet above the rails. To the uninitiated these immense machines have an exceedingly top-heavy appearance, and it looks as though their stability would be endangered, especially when they are running at high speed around a curve. Before sending this engine out of the shops, the Rogers Locomotive Company made an experimental test to determine the exact location of its center of gravity. The result is certainly surprising, for although the top of the boiler is fully 9 feet above the rails, the center of gravity was found to be only 50½ inches above the top of the rails, that is to say, about 6½ inches below the top of the driving wheels. As a matter of fact, the great bulk of the boiler is very deceptive to the eye, and one is liable to forget that the greatest concentration of weight lies in the heavy frame, the wheels, the axles, cranks and running gear, and the heavy saddle and cylinder castings. The test was made by suspending the engine on the upper surface of two 3-inch steel pins or journals as pivots, the one at the front being located 6 inches in front of the cylinder saddle, and the one at the rear 6 inches back of the boiler, both pivots being, of course, the same distance above the rails and on the vertical center line of the engine. After several trials, points of suspension were found which were in line with the center of gravity, which, as thus determined, was found to be 50½ inches above the top of the rail. As the bearing points of the drivers on the rails are about 56 inches apart, the base on which the engine runs must be 1.1 times as wide as the height of the center of gravity of the engine above the rails. It is evident from this test that the center of gravity of such a locomotive could be raised still higher without endangering the stability of the engine under the ordinary conditions of service.



Eight locomotives would haul "Oceanic" on the level at 22 miles per hour. Weight of "Oceanic" represented by two trains, each of 443 cars and 3 miles in length



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A COMPARISON OF MARINE ENGINE AND LOCOMOTIVE POWER.

### A COMPARISON OF MARINE ENGINE AND LOCOMOTIVE HORSEPOWER.

In order to secure a basis for comparison of the power of a modern freight locomotive with that of a modern steamship, we have chosen the "Oceanic." This truly gigantic ship, which exceeds the "Great Eastern" in length and in displacement, is 704 feet in length, and on a draft of 32½ feet displaces 28,500 tons. As the depth of water in the entrance channels to New York Harbor will not accommodate a vessel drawing that amount, for the purpose of this comparison we will suppose that the "Oceanic" is drawing 30 feet, at which draft she would displace about 26,000 tons. On this displacement her engines will indicate about 28,000 horsepower when driving the vessel at a speed of 22 land miles an hour.

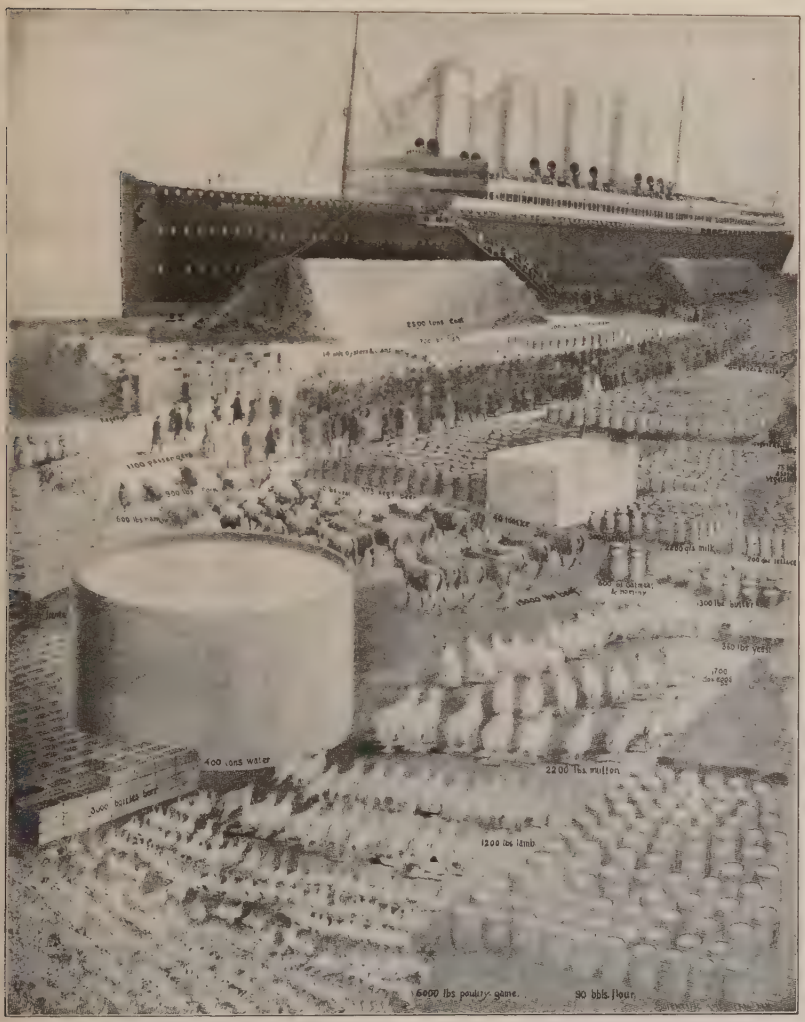
Now, it is estimated that the big Rogers Consolidation could haul about 3,250 tons weight of train at a speed of 22 miles an hour, on the level, and that while doing this work it would indicate about 1,760 horsepower. Here then we have a basis of comparison, and we may apply it in two ways. Either we may ask how many of these locomotives would have to be crowded into the hold of the "Oceanic," and coupled to her main shafts, in order to drive her through the water at 22 miles an hour, or we may determine how many of these locomotives it would take to haul the "Oceanic" if she were placed upon a movable cradle of the kind designed by Captain Eads for his Tehuantepec Ship Railway. In the first case, we know that when the main shafts of the "Oceanic" are making about 90 turns a minute, the engines are indicating about 28,000 horsepower, which is their maximum capacity. On the other hand, we know that when the drivers of one of these locomotives are making about 150 turns a minute, and the maximum tractive effort is being exerted at the periphery of the wheels, it is indicating about 1,760 horsepower, which represents its possible maximum indication at that speed. If now the sixteen necessary locomotives (the number being found by dividing the horsepower of the ship by the horsepower of the locomotive) were arranged in two lines, one above each main shaft, and the tractive effort of the drivers transmitted by means of friction wheels to the shafts, the speed of the rotation being reduced by intermediate gearing, in the ratio of 150 to 90, we should have the conditions shown in the engraving on the previous page, where the locomotives, in double phalanx, are shown grinding merrily away at their unwonted task of driving a modern transatlantic liner.

To determine how many Rogers Consolidations it would take to haul the "Oceanic" over a ship railway whose grade is perfectly level, we will neglect the weight of the cradle and assume that its rolling friction is the same as that of a weight of loaded freight cars, equal to that of the ship. The displacement (that is, the weight of the water which the ship displaces at a given draft) on a draft of 30 feet would be about 26,000 tons, and dividing this amount by 3,250 tons, which is the maximum weight of train which one locomotive can haul at 22 miles an hour, we find that it would take just eight locomotives to haul the "Oceanic" by rail at a speed of 22 miles an hour. This result is particularly interesting as showing how quickly the resistance of the water to the motion of the ship increases with the speed. As a matter of fact it increases as the cube of the speed, with the result that, although the "Oceanic" could be moved at a canal-boat speed of 2½ miles an hour by less locomotives than it would take to haul it at that speed on land, at a speed of 22 miles an hour it requires just twice the power on the water that it would on the land.

The "Oceanic," as she rests upon the ship railway cradle, represents both the dead and the live load; that is to say, the ship and the cargo. With a view to showing graphically what an enormous mass is represented by her 26,000 tons displacement, attention is drawn to the sketch showing an equivalent weight in loaded box cars of 40,000 pounds capacity, each of which with its load would weigh about thirty long tons. If this weight were made up into two separate trains each train would contain 433 cars and would be about three miles in length.

---

Between Brussels and Charleroi there is a length of nearly 30 miles of canal served by overhead wires. The motor "tractors" run on the rough canal towpath, with plain wheels of hard steel. In another style on the Finow and the Tetlow Canals, the "tractor" runs on a single rail by the pair of wheels on one side, and on the towpath by a plain pair of wheels on the other side.

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SUPPLIES OF THE "DEUTSCHLAND."

## SUPPLIES OF THE "DEUTSCHLAND."

Not by any means the least impressive evidence of the huge size to which the modern transatlantic steamship has grown is to be found in the graphic representation, now presented, of the bewildering amount of provisions that have to be taken aboard for a single trip across the ocean. A mere tabulation of the various kinds of food which go to replenish the ship's larder, during the few days which she spends in port, fails to convey any adequate idea of the vast amount of stores taken aboard. Our pictorial representation is, of course, purely imaginary, particularly as regards the live stock; the beef, mutton, game, etc., being received on the ship in the dressed condition, no live stock whatever being carried. The drawing was made up from a list of the actual amount of provisions carried on a recent eastward trip on the Hamburg-American liner "Deutschland," and the number of live stock which contributed to meet the supplies for one voyage was estimated from the actual number of cattle, sheep, etc., that would be required to make up the total weights in dressed meats. With the exception of the live stock, the provisions are shown in the actual shape in which they would be taken on board.

The dimensions of the vessel are: Length, 686 feet; beam, 67 feet, and displacement, 23,000 tons; her highest average speed for the whole trip is 23.36 knots, and she has made the journey from Sandy Hook to the Lizard in five days seven hours and thirty-eight minutes. In considering the question of feeding the passengers on a vessel of this size, the thought is suggested that here are other hungry mouths within the hull of the ship besides those to be found in the dining saloons of the passengers and the messrooms of the crew; mouths that are so voracious that they require feeding not merely at the three regular meal hours of the ship, but every hour of the day and night, from the time the moorings are cast off at one port until the vessel is warped alongside at the other. We refer to the 112 furnaces in which the fuel of the sixteen boilers in the boiler-room is consumed at the rate of 572 tons per day. Now, although the voyage from New York to Hamburg lasts only six or seven days, according to the state of the weather, the bunkers of the ship are constructed to hold a sufficiently large reserve of coal to cover all contingencies, her total coal capacity being about 5,000 tons; and at each voyage care is taken to see that they are pretty well filled.

The total number of souls on board of the vessel when she has a full passenger list is 1,617, made up of 467 first cabin, 300 second cabin, 300 steerage and a crew of 550, the crew comprising officers, seamen, stewards and the engine-room force. Sixteen hundred and seventeen souls would constitute the total inhabitants of many an American community that dignifies itself with the name of "city," and it is a fact that the long procession which is shown in our illustration, wending its way through the assembled provisions on the quay, by no means represents the length of the line were the passengers and crew strung out along Broadway or any great thoroughfare of that city. If this number of people were to march four deep through Broadway, with a distance of say about a yard between ranks, they would extend for about a quarter of a mile, or say the length of five city blocks.

To feed these people for a period of six days requires, in meat alone, the equivalent of fourteen steers, ten calves, twenty-nine sheep, twenty-six lambs, and nine hogs. If the flocks of chickens, geese and game required to furnish the three tons of poultry and game that are consumed were to join in the procession aboard the vessel, they would constitute a contingent by themselves not less than 1,500 strong. The ship's larder is also stocked with 1,700 pounds of fish, 400 pounds of tongues, sweetbreads, etc., 1,700 dozen eggs and 14 barrels of oysters and clams. The 1,700 dozen eggs packed in cases would cover a considerable area, as shown in our engraving, while the 1,000 brick of ice cream would require 100 tubs to hold them. Of table butter there would be taken on board 1,300 pounds, while the 2,200 quarts of milk would require 64 cans to hold it, and the 300 quarts of cream 8 cans.

In the way of vegetables there are shipped on board 175 barrels of potatoes, 75 barrels of assorted vegetables, 20 crates of tomatoes and table celery, 200 dozen lettuce; while the requirements of dessert alone would call for 4 1-4 tons of fresh fruits. For making up into daily supply of bread, biscuits,

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A GRAPHICAL COMPARISON OF THE PROVISIONS OF A TRANSATLANTIC LINER.

cakes, pies, and the toothsome odds-and-ends of the pastry cook's art, there are taken on board at each trip 90 barrels of flour, each weighing 195 pounds, this item alone adding a weight of 8½ tons to the cooks' stores. To this also we must add 350 pounds of yeast and 600 pounds of oatmeal and hominy.

Under the head of liquids the most important item is the 400 tons of drinking water, whose bulk is adequately represented by the circular tank shown in our engraving. This is supplemented by 12,000 quarts of wine and liquors, 15,000 quarts of beer in kegs, besides 3,000 bottles of beer. Last, but not by any means least, is the supply of 40 tons of ice.

Of course, it will be understood that, as in the case of the coal, it is not to be supposed that all of this supply will be consumed on the voyage. There must be a margin, and a fairly liberal margin, of every kind of provision. Moreover, the extent to which the larder and cellar are emptied will vary according to the condition of the voyage. In tempestuous weather, where the trip is a succession of heavy gales, and the dining room tables are liable to be practically deserted for two or three days at a stretch, the consumption will be modified considerably. Stormy voyages of this character, after all, occur at infrequent intervals, and as a rule the supplies are pretty well consumed by the time the passage is over.

Now, having dealt with the general food supplies, we will deal with the food supplies of another large liner for a single trip.

## PROVISIONING THE "KRONPRINZ WILHELM" FOR A SINGLE TRANSATLANTIC TRIP.

The Book of Genesis does not record the tonnage of the huge vessel which finally stranded on Mount Ararat, after finishing the most wonderful voyage ever described in the annals of mankind. But it is quite safe to assume that the dimensions of the Ark, that old-time floating storehouse, are exceeded in size by the largest of steamships now crossing the Atlantic.

Not the least striking evidence of the size of these modern monsters of the deep is afforded by the vast quantities of food which must be taken aboard for a single six-day trip across the Atlantic. For the 1,500 passengers and the several hundred men constituting the crew, carloads of food and whole tanks of liquids are necessary. To enumerate in cold type the exact quantities of bread, meat, and vegetables consumed in a weekly trip would give but an inadequate idea of the storing capacity of a modern liner. We have, therefore, prepared a picture which graphically shows by comparison with the average man the equivalent of the meat, poultry, and breadstuffs, as well as the liquors used. Each kind of food has been concentrated into a giant unit, compared with which the figure of the average man seems puny.

On the "Kronprinz Wilhelm," of the North German Lloyd Line, which steamship we have taken for the purpose of instituting our comparisons, some 19,800 pounds of fresh meat and 14,300 pounds of salt beef and mutton, in all 34,100 pounds of meat, are eaten during a single trip from New York to Bremen. This enormous quantity of meat has been pictured in the form of a single joint of beef, which, if it actually existed, would be somewhat less than 10 feet high, 10 feet long, and 5 feet wide. If placed on one end of a scale, it would require about 227 average men in the other end to tip the beam.

For a single voyage the "Kronprinz Wilhelm" uses 2,640 pounds of ham, 1,320 pounds of bacon, and 506 pounds of sausage—in all, 4,466 pounds. Since most of this is pork, it may well be pictured in the form of a ham. That single ham is equivalent in weight to 374 average hams. It is 7¼ feet high, 3 feet in diameter and 2 feet thick.

The poultry eaten by the passengers of the steamer during a trip to Bremen or New York weighs 4,840 pounds. Suppose that we show these 4,840 pounds of poultry in the form of a turkey, dressed and ready for the oven. The bird would be a giant 10 feet long, 8 feet broad, and 5 feet high.

Sauerkraut, beans, peas, rice, and fresh vegetables are consumed to the amount of 25,320 pounds. Packed for market, these preserved and fresh vegetables would be contained in 290 baskets of the usual form, which piled up make a formidable truncated pyramid.

The quantity of eggs required is no less startling than the quantity of vegetables, for some 25,000 are needed to satisfy the wants of passengers and crew. Eggs are usually packed in cases, 30 dozen to the case. The "Kronprinz Wilhelm," when she leaves New York or Bremen, must therefore take on board 69 of these cases, which have been shown in a great pile, 23 cases high and 3 cases wide.

The bakers of the ship find it necessary to use 33,000 pounds of flour during the trip. In other words, 169 barrels are stowed away somewhere in the hold of the big ship.

Besides the foods already enumerated, 1,980 pounds of fresh fish and 330 pounds of salted fish are eaten during the six-day voyage. The total amount of 2,310 pounds would be equivalent to a single bluefish 20 feet long, 5 feet in greatest diameter, and 1½ feet broad. Such a fish compares favorably in length, at least, with a good-sized whale.

The potatoes required far outweigh any other single article of food contained in the storerooms; for their entire weight is 61,600 pounds. If it were possible to grow a single tuber of that weight, it would have a height of 14 feet and a diameter of 7 feet.

The butter, too, if packed into a single tub, would assume large dimensions. This single tub would contain 6,600 pounds, and would be 6 feet high.

Of dried fruit, 2,640 pounds are eaten, and of fresh fruit 11,000 pounds, in all 13,640 pounds. If this fruit were all concentrated into a single pear, its height would be 7 feet, and the width at the thickest part 5 feet.

Whole lakes of liquids are drunk up by the thirsty passengers and crew. No less than 425 tons of fresh water are required, which occupy 14,175 cubic feet and would fill a tank 25 feet in diameter and 30 feet high. The 1,716 gallons of milk used for drinking and cooking would be contained in a can 6 feet 1 inch in diameter and 11½ feet high. The gallons and gallons of wines, liquors, and beer consumed should dishearten the most optimistic temperance advocate. Under the joyous title of "beverages" the following items are to be found in the purser's account book:

| | |
|---|---|
| Champagne | 850 bottles. |
| Claret | 980 bottles. |
| Madeira, sherry, etc. | 135 bottles. |
| Rhine and Moselle wines. | 1,700 bottles. |
| Rum and cordials | 760 bottles. |
| Mineral water | 5,250 bottles. |
| Beer in kegs | 2,960 gallons. |
| Beer in bottles | 600 bottles. |

Suppose these things to drink were contained in one claret bottle. Some idea of the hugeness of this bottle may be gained when it is considered that its height would be over 24 feet and its diameter over 6 feet.

## THE ATLANTIC LINERS.

NEW CUNARDERS—PASSENGERS CARRIED—PRICE OF SPEED—ATLANTIC TRUST.

THE NEW CUNARDERS.—The most notable event in shipping circles during 1903 was the government agreement with the Cunard Company, for the building of two vessels of higher speed than any liners in existence. It is an eminently desirable and satisfactory arrangement from the British point of view, and the development of its scientific and technical aspects will be followed with an intensity of interest which can perhaps only be paralleled within living memory by the construction of the "Great Eastern." The reasons for this we shall note directly.

CUNARD AGREEMENT.—Ten years have elapsed since the "Campania" and "Lucania" made the last British record of 22 knots, since which period five German liners have eclipsed the performance of these ships. It is confidently believed that the Cunard Company will be able to exceed the limits imposed by the government terms—of a minimum average ocean speed of 24½ knots an hour in moderate weather. This will be a knot above the "crack" German vessels.

Subject to certain very fair conditions, the government will advance a sum not exceeding $3,000,000 for the building of the two new vessels. This will be secured by a charge upon the whole of the company's assets. It is to be advanced in instalments on the inspector certifying the attainment of certain stages of progress in the work, and the sum will have to be repaid in twenty yearly instalments.

For the mail service the company will receive $340,000 per annum, with extra payment for mails weighing over 100 tons (or 4,000 cubic feet measure-

ment), carried in any one week. The plans for the vessels are not yet made public.

THE FAST BOATS.—That the new departure will pay seems assured, because statistics show that the fastest boats, notwithstanding their higher rates, attract more passengers than the slower boats do. The latter are just as comfortable, and the cuisine is the same, yet a knot or two more in speed doubles and trebles the first-class passengers, to whom in many cases time is money.

Thus, in one week in April, 1903, the "Kaiser Wilhelm II." left New York with 521 first-class, and 355 second-class passengers, while on the same day a vessel of the American Line left with only 82 first-class and 72 second-class passengers. On one day in May the "Kronprinz Wilhelm" left with 380 first and 187 second class passengers, while on the following day a White Star liner took 149 first and 160 second class. Such significant contrasts might be largely multiplied.

"CEDRIC" RECORD.—The big fast ships suffer less from rough weather than the smaller, slower ones, and that apart from speed attracts. The surgeon of the "Cedric," next to the largest liner, reported that on her maiden voyage not a single passenger was seasick. A wine glass, brimming full, was placed on the edge of a sideboard, and left undisturbed throughout the voyage, but not a drop was spilled, nor did the glass move.

THE PRICE OF SPEED.—The increased price that must be paid for speed is a matter that lies in a nutshell. The reason is that a slight advance in speed requires an immense increase in engine power and vast coal storage. These increase the displacement, which again makes still greater demands on the power required. By the time these are provided for, there is no cargo space left worth mentioning. There the limit to size for that speed is reached, and to obtain higher rates involves bigger vessels. This, too, explains why improvements in the design of and economical working of engines and boilers is so eagerly sought after with a view to reduce the cubical space required for these in the hull, and is also one reason why steam turbines are being put on vessels of increasingly large dimensions.

COST IN COAL.—The Admiralty Committee on "Subsidies to Merchant Cruisers" have issued some tabular statements which show the price of speed in a very graphic way. From one of these we see that while a 20-knot steamer consumes 2,228 tons of coal on a 3,000 mile voyage, a 26-knot one will be expected to consume 6,131 tons; and that the 19,000 horsepower of the first must give place to the enormous total of 68,000 horsepower for the last. The cost again of the vessel is $1,750,000 in the slower ship, and $6.250,000 in the swifter. A heavy price truly to pay for the extra six knots! But the investment is a good one on passenger liners, as the previous paragraph shows. The next table shows these and other points in a striking manner:

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Speed, in knots | 20 | 21 | 22 | 23 | 24 | 25 | 26 |
| Time of voyage (chronometer hours) | 150 | 143 | 136 | 130 | 125 | 120 | 115.5 |
| Prime cost, dollars | 1,750,000 | 2,000,000 | 2,350,000 | 2,875,000 | 4,250,000 | 5,000,000 | 6,250,000 |
| Indicated horsepower | 19,000 | 22,000 | 25,500 | 30,000 | 40,000 | 52,000 | 68,000 |
| Length, in feet | 600 | 630 | 660 | 690 | 720 | 750 | 780 |
| Displacement tonnage | 13,000 | 15,000 | 17,300 | 19,800 | 22,400 | 25,400 | 28,500 |
| Coal, in tons | 2,228 | 2,456 | 2,912 | 3,058 | 3,900 | 4,876 | 6,131 |
| Steam pressure, pounds per square inch | 150 | 165 | 181 | 198 | 216 | 234 | 254 |
| Machinery department, number of hands | 100 | 110 | 125 | 150 | 200 | 260 | 340 |

The following table compiled from Lloyd's gives the number of vessels built in Great Britain, arranged according to size. They vary somewhat from the returns quoted on other pages.

| Vessels. | Under 200 Tons. | 200 to 399 Tons. | 400 to 599 Tons. | 600 to 799 Tons. | 800 to 999 Tons. | 1,000 to 1,499 Tons. | 1,500 to 1,999 Tons. | 2,000 to 2,999 Tons. | 3,000 to 3,999 Tons. | 4,000 to 4,999 Tons. | 5,000 to 6,999 Tons. | 7,000 to 9,999 Tons. | 10,000 Tons and above. | Grand Total. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | No. | Tonn'ge. |
| Sail | 4 | — | — | — | — | — | 6 | 6 | 3 | — | — | — | — | 19 | 36,384 |
| Steam | 77 | 69 | 25 | 15 | 10 | 34 | 36 | 53 | 89 | 60 | 41 | 19 | 9 | 537 | 1,376,327 |
| Total | 81 | 69 | 25 | 15 | 10 | 34 | 42 | 59 | 92 | 60 | 41 | 19 | 9 | 556 | 1,412,711 |

## STEAM TURBINES AND SPEED.

GROWTH OF THE STEAM TURBINE.—The steam turbine has been applied to the propulsion of vessels, and is steadily growing in favor.

The number of vessels so fitted is not large, but the development is none the less remarkable when we remember that pleasure, and cross-channel steamers, torpedo-boat destroyers, and yachts are now fitted with these engines, while ten years ago not one turbine vessel was in service.

EARLY TYPES.—The "Turbinia," 1894, was the first of the kind, followed by the "Viper," 1898, and the "Cobra." The "King Edward," 1901, was the first passenger steamer so fitted, followed by the "Queen Alexandra," 1902, both for passenger service on the Clyde.

CROSS-CHANNEL BOATS.—The success of these vessels was the immediate cause of the application of the steam turbine to the cross-channel services—the "Queen" for the Dover-Calais route, and the "Brighton," the Newhaven-Dieppe boat. On an unofficial trip made in August, 1903, this vessel maintained a speed of 20 knots. The "Brighton" is 282 feet in length, and accommodates 1,000 passengers. Her engines are rated at 7,000 horsepower. The reversing turbines are fitted to the outside screw shafts, and are capable of moving her astern at about 12 knots. The lubrication of the engines is automatic, the oil being supplied at a pressure of 6 lbs. per square inch. The "Queen" has also behaved excellently, running between Dover and Calais within the hour, in a gale of wind.

IRISH BOATS.—Two steam turbine vessels are being built for the Midland Railway service between England, the Isle of Man, and Belfast. Two others of the same class will be fitted with ordinary reciprocating engines, so that relative tests of the two kinds of propulsion will be available under equal conditions. The steamers will be of 20 knots speed, 330 feet long, by 40 feet beam, and 25 feet depth.

THREE YACHTS have been fitted with steam turbines. Two torpedo-boat destroyers, the "Velox" and the "Eden," and the "Amethyst," third-class cruiser, are designed for turbine propulsion. the first being in commission, the others at the time of writing being on order.

A COMMISSION has been appointed, at the suggestion of Lord Inverclyde, to investigate the question of the economy of steam turbines and their suitability to the new big Cunarders. The commission comprises representatives of the Admiralty, the Cunard Company, Lloyd's, and three shipbuilders. At the time of writing no decision has been published. But the fact of such a commission having been appointed testifies to the rapid headway which the turbine is making. But two or three years since, most shipbuilders would have declined even to seriously entertain or to discuss such a proposal. The Allan Line and the Union Steamship Co. are building a 17 and an 18-knot turbine vessel respectively.

OBJECTIONS.—Though the above is not a large list, it must be remembered that shipowners and the Admiralty are naturally very cautious in fitting vessels with novel means of propulsion. The whole history of steam navigation is one of slow but sure advances. The installation of water-tube boilers is another case in point.

The great objection to the use of turbines for driving ocean liners is that this form of engine does not reverse. A separate set of engines is employed for reversing, at lower speeds. The captains of big vessels strongly object to this, because they say that even greater power would be desirable for going astern than ahead, in order to avoid sudden collision.

LAND TURBINES.—On land, Parsons' turbines are being used extensively for driving electric generators, aggregating about 250,000 horsepower, and in sizes up to 5,000 horsepower. Yet the first practical steam turbine was not built until 1884, and that is now in the South Kensington Museum. A recent computation gives the total aggregate power of steam turbines of all types in use, under construction, or ordered, in different parts of the world, at over 500,000 horsepower.

ADVANTAGES OF TURBINES.—The principal point in favor of a turbine is, that it has no reciprocating motion, like that of the piston of a common engine, and therefore the hull of a vessel is not shaken so much as by reciprocating engines. Turbine en-

gines weigh much less, and occupy less room than ordinary engines of the same power, so that passenger accommodation can be increased. Usually three sets of engines are employed, each driving a separate propeller shaft, which again conduces to steadiness of motion.

EXPIRATION OF PARSONS' PATENT.—Several circumstances have occurred latterly to help on the progress of the steam turbine besides its recent successful application to steam yachts, Clyde pleasure steamers, and cross-channel services. One of these is the expiration during the year 1903 of the five years' extension of the patent that was granted to the Hon. C. A. Parsons in 1884. A result of this is that several firms now express their intention of going in for the manufacture of Parsons' turbines. Another is that the success of these turbines has acted as a stimulus to other inventors, and the Parsons turbine will have to face the rivalry of others, including the De Laval, and another promising one, that of Mr. C. G. Curtis, of New York.

It is safe to predict that the old-fashioned steam engines, the big mill type excepted, will gradually give place to the steam turbines, and to the gas and oil engines. Apart from economy and compactness, the turbines are cleaner than any other engines, being self-lubricating and enclosed.

—*Daily Mail Year Book.*

## UNITED STATES LIFE-SAVING SERVICE.

The number of disasters to documented vessels within the scope of the Service was 359 for the fiscal year ending June 30, 1904. On board these vessels were 2,525 persons, of whom 21 were lost. The estimated value of the vessels was $4,698,855 and that of their cargoes $1,757,925, making the total value of property involved $6,456,780. Of this amount $5,089,950 was saved and $1,366,830 lost. The number of vessels totally lost was 50. In addition to the foregoing there were 411 casualties to undocumented craft—sailboats, rowboats, etc.—carrying 803 persons, 13 of whom perished. The value of property involved in these instances is estimated at $248,750, of which $240,130 was saved and $8,620 lost.

The results of disasters to vessels of all descriptions within the scope of the Service, therefore, aggregate as follows:

| | |
|---|---|
| Total number of disasters | 770 |
| Total value of property involved | $6,705,530 |
| Total value of property saved | *$5,330,080 |
| Total value of property lost | $1,375,450 |
| Total number of persons involved | 3,328 |
| Total number of persons lost | 34 |
| Total number of shipwrecked persons succored at stations | * 659 |
| Total number of days' succor afforded | * 1,311 |
| Number of vessels totally lost | 50 |

The foregoing summary does not include 103 persons not on board of vessels who were rescued from various positions of peril.

### VESSELS ASSISTED.

The life-saving crews saved and assisted in saving 480 imperiled vessels, valued, with their cargoes, at $2,447,935. Of this number, 384, valued with their cargoes at $998,125, were saved without other assistance. In the remaining instances, 96 in number, the life-saving crews co-operated with wrecking vessels, tugs, and other agencies in saving property estimated at $1,135,565, out of a total value of $1,449,810 imperiled. Besides this the crews afforded assistance of greater or less importance to 581 other vessels, rendering aid, therefore, altogether to 1,061 vessels of all kinds, including small craft. This number is exclusive of 161 instances in which vessels running into danger were warned off by station patrolmen. One hundred and forty-eight of these warnings were given at night by Coston lights.

The apportionment of the foregoing statistics to the Atlantic, Lake, and Pacific coasts, respectively, is shown in the following table:

*It should not be understood that the entire amount represented by these figures was saved by the Service. A considerable portion was saved by salvage companies, wrecking tugs, and other instrumentalities, often working in conjunction with the surfmen. It is manifestly impossible to apportion the relative results accomplished. It is equally impossible to give even an approximate estimate of the number of lives saved by the station crews. It would be preposterous to assume that all those on board vessels suffering disaster who escape would have been lost but for the aid of the life-savers; yet the number of persons taken ashore by the lifeboats and other appliances by no means indicates the sum total saved by the Service.

APPORTIONMENT TO ATLANTIC, LAKE AND PACIFIC COASTS.

| Disasters to Vessels. | Atlantic and Gulf coasts. | Lake coasts. | Pacific coast. | Total. |
|---|---|---|---|---|
| Total number of disasters | 477 | 249 | 44 | 770 |
| Total value of vessels.....dollars. | 3,018,890 | 1,536,765 | 372,585 | 4,928,240 |
| Total value of cargoes.....do. | 1,267,825 | 454,940 | 54,525 | 1,777,290 |
| Total amount of property involved...do. | 4,286,715 | 1,991,705 | 427,110 | 6,705,530 |
| Total amount of property saved.....do. | 3,666,895 | 1,443,790 | 219,395 | 5,330,080 |
| Total amount of property lost.....do. | 619,820 | 547,915 | 207,715 | 1,375,450 |
| Total number of persons on board | 2,171 | 914 | 243 | 3,328 |
| Total number of persons lost | 22 | 6 | 6 | 34 |
| Number of shipwrecked persons succored at stations | 504 | 115 | 40 | 659 |
| Total number of days' succor afforded | 948 | 317 | 46 | 1,311 |
| Number of disasters involving total loss of vessels | 33 | 12 | 5 | 50 |

GENERAL SUMMARY

Of disasters which have occurred within the scope of life-saving operations from November 1, 1871 (date of introduction of present system), to close of fiscal year ending June 30, 1904.*

| | |
|---|---|
| Total number of disasters | 14,846 |
| Total value of vessels | $153,026,275 |
| Total value of cargoes | $64,030,934 |
| Total value of property involved | $217,057,209 |
| Total value of property saved | $171,583,102 |
| Total value of property lost | $45,474,107 |
| Total number of persons involved | †105,905 |
| Total number of lives lost | ‡1,061 |
| Total number of persons succored at stations | §18,306 |
| Total number of days' succor afforded | 44,317 |

The Board on Life-Saving Appliances was constituted by the Secretary of the Treasury January 3, 1882, and meets periodically for the transaction of such business as may come before it. Inventors and exhibitors are allowed to appear before the court to explain the methods of construction and set forth the merits claimed for their devices. Committees are then appointed to consider the various devices submitted to the Board, and each committee reports upon each device, and the results are published in the Report of the Board on Life-Saving Appliances, which is incorporated in the Annual Report of the United States Life-Saving Service.

## THE LIGHTHOUSE ESTABLISHMENT.

There are under the control of the Lighthouse Establishment, Oct. 7, 1904, the following named aids to navigation:

| | |
|---|---|
| Light-houses and beacon lights | 1,423 |
| Light-vessels in position | 46 |
| Light-vessels for relief | 8 |
| Gas-lighted buoys in position | 130 |
| Fog-signals operated by steam, caloric, or oil engines, about | 197 |
| Fog-signals operated by machinery, about | 233 |
| Post lights, about | 1,868 |
| Day or unlighted beacons, about | 668 |
| Whistling buoys in position, about | 88 |
| Bell buoys in position, about | 139 |
| Other buoys in position, including pile buoys and stakes in Fifth district and buoys in Alaskan waters | 5,088 |

In the construction, care and maintenance of these aids to navigation there are employed:

| | |
|---|---|
| Steam tenders | 40 |
| Steam launches | 7 |
| Sailing tenders | 1 |
| Light-keepers, about | 1,525 |
| Officers and crews of light-vessels and tenders, about | 1,279 |
| Laborers in charge of post lights, about | 1,600 |

* It should be observed that the operations of the Service during this period have been limited as follows: Season of 1871-72, to the coasts of Long Island and New Jersey; seasons of 1872-74 to the coasts of Cape Cod, Long Island, and New Jersey; season of 1874-75, to the coasts of New England, Long Island, New Jersey, and the coast from Cape Henry to Cape Hatteras; season of 1875-76, to the coasts of New England, Long Island, New Jersey, the coast from Cape Henlopen to Cape Charles, and the coast from Cape Henry to Cape Hatteras; season of 1876-77 and since, all the foregoing with the addition of the eastern coast of Florida and portions of the lake coasts. In 1877-78 the Pacific coast was added, and in 1880 the coast of Texas.

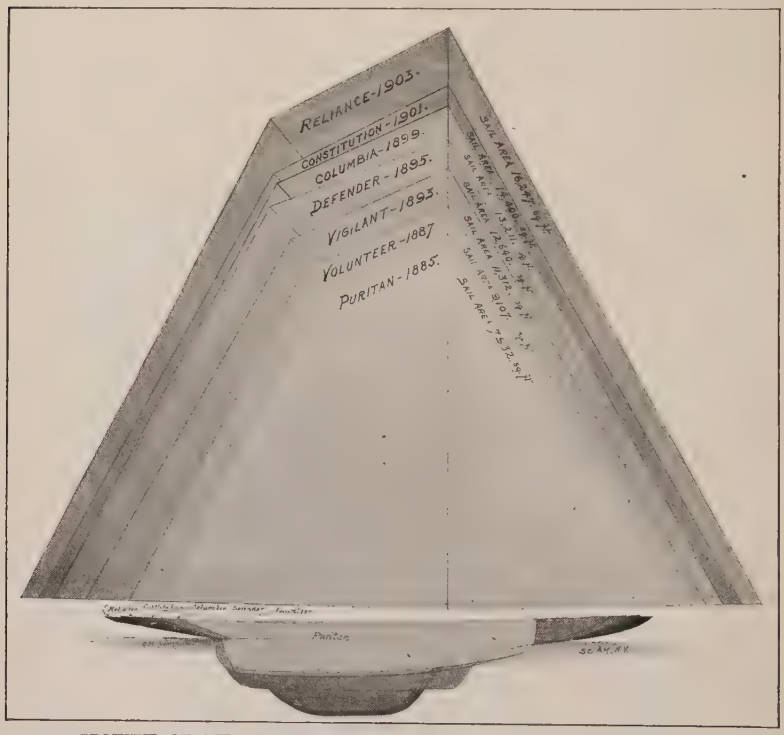
† Including persons rescued not on board vessels.

‡ Eighty-five of these were lost at the disaster to the steamer *Metropolis* in 1877-78, when service was impeded by distance, and 14 others in the same year owing to similar causes.

§ Including castaways not on board vessels embraced in Tables of Casualties.

## FROM CRUISER TO RACING MACHINE.

What might be called the scientific period of yacht designing in this country begins at about the period of the races of "Puritan" against "Genesta," in 1885. The growth to the exaggerated proportions of hull and sail plan shown in our accompanying diagram, is the logical and inevitable outcome of a rule of measurement altogether too broad and loose in its specifications. The only elements taxed in this rule are length on the water-line when on an even keel, and total sail area. To the competing designers the rule has said, "When your yachts are placed under the measurer's tape, if 90-footers they must not be over 90 feet long on the water-line, or if 70-footers not over 70 feet. If you choose to make them a little less than these lengths, their rating will be diminished accordingly. Outside of this restriction you may do just anything you please in modeling your hulls. They may be built of any material; they may be broad or narrow, shallow or deep; light and leakable as a wicker basket, or tight and heavy as an ironclad. As to the spread of sail, you may crack on just as much as you please; always with the understanding, however, that the more you carry the greater will be your racing measurement."




GROWTH OF THE AMERICAN CUP DEFENDER FROM CRUISER TO RACING MACHINE.

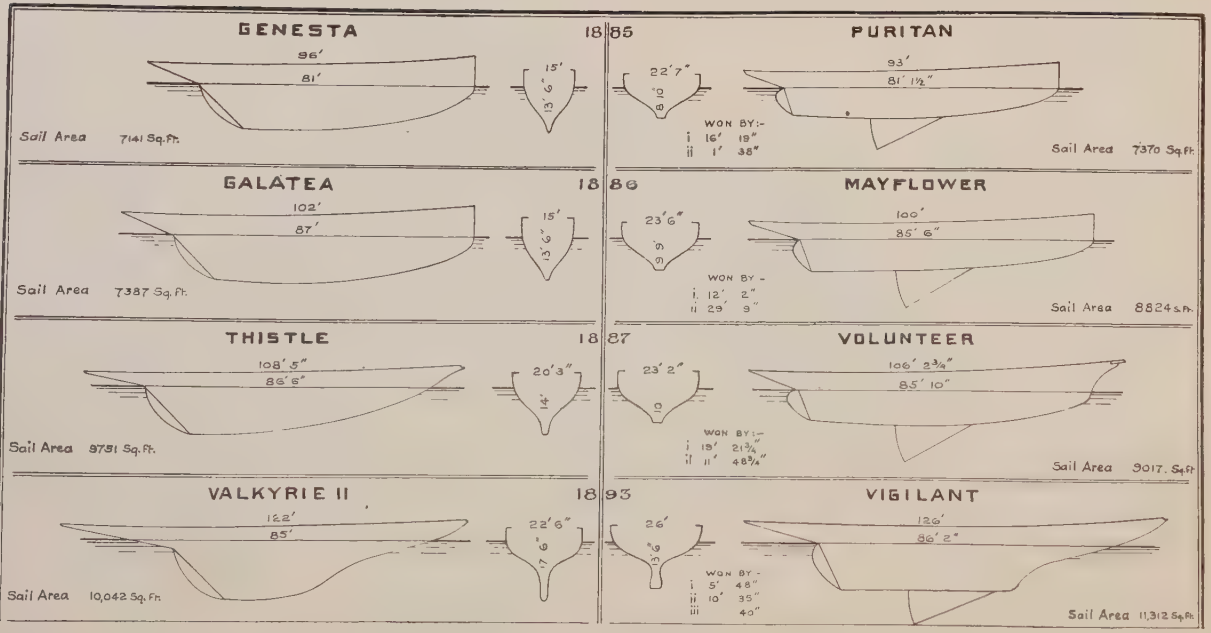
Now at the time of the "Puritan"-"Genesta" races, our yacht designers were beginning to emerge from the rule-of-thumb methods that characterized the days of the center-board sloop

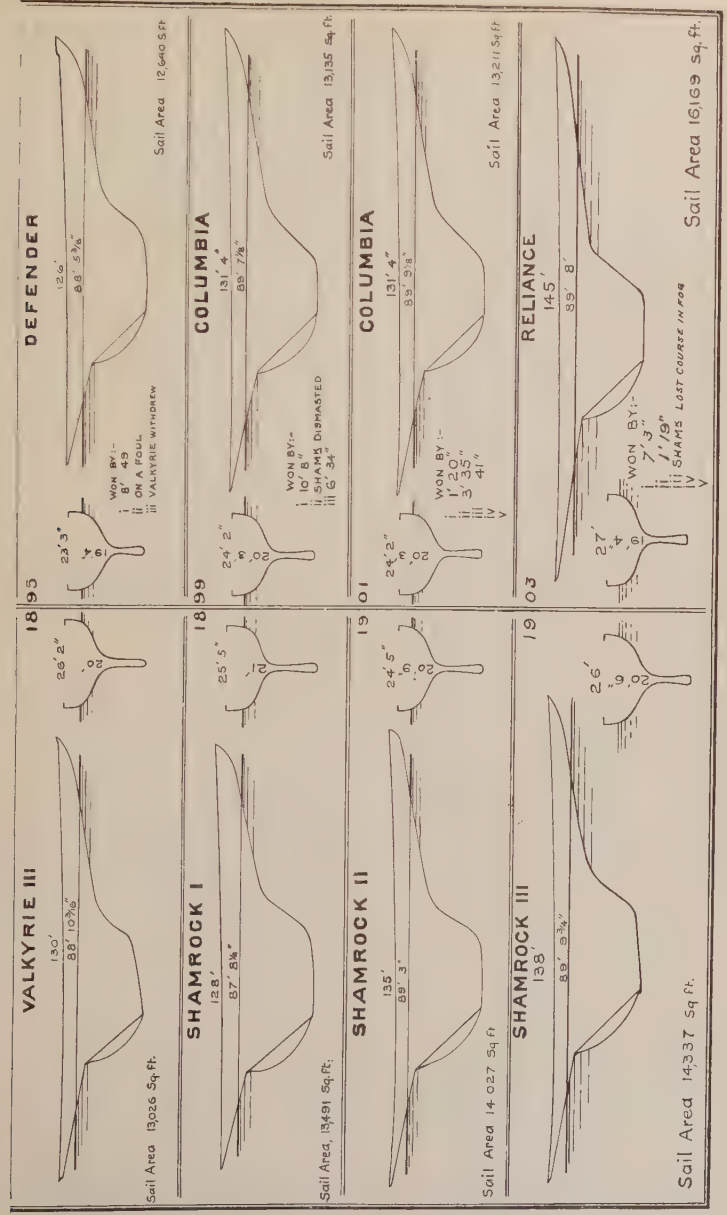
and schooner, and were beginning, thanks to the victorious career of one or two imported deep-keel English cutters, to appreciate the value of outside lead as an element of sail-carrying power. Hence, the "Puritan" carried a large proportion of her 48 tons of lead ballast on the keel, and although she was marked by the shoalness of body and limited draft of the prevailing centerboard type, she was an extremely able sea boat, fast and comfortable, a wooden vessel of first-class construction, with a reasonable spread of sail which she was well able to carry in a blow, as was proved in that memorable race of twenty miles to leeward and back in half a gale of wind in which she won by a narrow margin over "Genesta." At the close of her racing career "Puritan" was changed from sloop to schooner rig, and to-day she is doing service as a snug and comfortable cruiser. "Mayflower," the next cup defender, was an improved "Puritan," with 5 feet more length on the water-line and 8,824 square feet of sail; she was built of wood, and subsequently to her defense of the cup she was turned into a comfortable cruiser. Her sail area is so nearly the same as that of her successor, "Volunteer," that to avoid crowding our drawing her sail-plan does not appear. "Volunteer" was designed by Burgess, the designer of "Puritan" and "Mayflower." She was the first of our large sloops to be built of steel. She was about 5 feet longer on the water-line than "Puritan" and carried a much larger sail-plan, the boom being 84 feet as against 76 1-2 feet of "Puritan," and the hoist to the topmast sheave being 111 feet as against 104 feet in the earlier boat. "Volunteer" also was a perfectly sound and wholesome vessel. Although her rig was a large one, she was well able to carry it; and like her predecessor she was changed after the cup races to a schooner, and is to-day in service as a successful cruiser. After a lapse of six years the New York Yacht Club was called upon once more to defend the cup, and on this occasion they went to Herreshoff, from whom they obtained two yachts, one of which, the "Colonia," was a keel boat, drawing 14 feet of water, built of steel, and carrying about 11,000 square feet of sail. She was a failure, for the reason that, like the "Navaho," another Herreshoff 90-footer of the same year, she was a poor boat on the wind.

The other yacht built for cup defense by Herreshoff was the "Vigilant," and in her we see the engineer attacking the problem of yacht design from his own particular point of view. Tobin bronze is used for the plating, hollow spars are experimented with, and high-grade steel wire rope, blocks and other gear of extreme lightness, make their appearance in the spar and sail-plans. As a consequence, although the "Vigilant" was only a few inches longer on the water-line than the "Volunteer," she carried over 2,000 square feet more sail. The boom was lengthened out to nigh upon 100 feet, while the hoist went up to 132 feet; and the sail spread to 11,312 square feet. "Vigilant" was to be the last of the centerboard yachts; for although she beat "Valkyrie II." in the series of races, she was beaten badly to windward by that boat in a stiff breeze; and subsequently, during a season in English waters, was beaten eleven times out of eighteen by the deep-keel cutter "Britannia," a sister boat to "Valkyrie II." That season's experience sealed the fate of the centerboard and when the next challenge came, the Herreshoffs, entrusted with the contract of

THE DEVELOPMENT OF THE 90-FOOT RACING YACHT.

| Yachts. | Water-line Length. | | Base of Fore Triangle. | | Hoist from Boom to Topmast Sheave. | | Boom. | | Gaff. | | Spinnaker Boom. | | Total Sail Area. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | ft. | in. | ft. | in. | ft. | in. | ft. | in. | ft. | in. | ft. | in. | sq. ft. |
| Puritan | 81 | 1½ | 62 | 0 | 104 | 0 | 76 | 6 | 47 | 0 | 62 | 0 | 7,370 |
| Mayflower | 85 | 7 | 67 | 0 | 111 | 0 | 80 | 0 | 50 | 0 | 67 | 0 | 8,824 |
| Volunteer | 85 | 10 | 67 | 0 | 111 | 0 | 84 | 0 | 51 | 6 | 67 | 0 | 9,107 |
| Vigilant | 86 | 2 | 69 | 0 | 122 | 0 | 98 | 0 | 57 | 0 | 69 | 0 | 11,312 |
| Defender | 88 | 5¾ | 73 | 3 | 129 | 5 | 106 | 0 | 64 | 10 | 73 | 4 | 12,640 |
| Columbia | 89 | 7¼ | 73 | 3 | 138 | 5 | 107 | 0 | 64 | 10 | 73 | 4 | 13,211 |
| Constitution | 89 | 9 | 78 | 0 | 142 | 0 | 110 | 0 | 72 | 0 | 78 | 0 | 14,400 |
| Reliance | 90 | 0 | 84 | 0 | 155 | 0 | 115 | 0 | 72 | 0 | 84 | 0 | 16,247 |


GENESTA
18 85
96'
81'
15'
13' 6"
Sail Area 7141 Sq. Ft.
PURITAN
22' 7"
8' 10"
93'
81' 1½"
WON BY:-
i 16' 19"
ii 1' 38"
Sail Area 7370 Sq. Ft.
GALATEA
18 86
102'
87'
15'
13' 6"
Sail Area 7387 Sq. Ft.
MAYFLOWER
23' 6"
9' 9"
100'
85' 6"
WON BY -
i 12' 2"
ii 29' 9"
Sail Area 8824 s.f.
THISTLE
18 87
108' 5"
86' 6"
20' 3"
14'
Sail Area 9751 Sq. Ft.
VOLUNTEER
23' 2"
10'
106' 2¾"
85' 10"
WON BY:-
i 19' 2¾"
ii 11' 48¾"
Sail Area 9017. Sq.ft
VALKYRIE II
18 93
122'
85'
22' 6"
17' 6"
Sail Area 10,042 Sq. Ft.
VIGILANT
26'
9' 9"
126'
86' 2"
WON BY -
i 5' 48"
ii 10' 35"
iii 40"
Sail Area 11,312 Sq.ft.




RACING YACHT FROM 1885 TO 1903.

building a yacht to beat her, turned out to meet her the deep-keel cutter-sloop "Defender." "Vigilant" was the last of the cup-defenders that was good for anything but cup defense. She has been changed into a yawl, and has proved to be an excellent cruiser under her reduced rig. In "Defender" we see the engineer still at work, reducing scantling and lightening up on construction even to the smallest detail. "Defender" was built of manganese bronze in the underbody, and aluminium in the topsides and framing. She carried a hollow steel mast, boom and gaff. As a consequence, although she was a smaller boat than "Vigilant," having some 3 feet less beam, so great was the lightening of her weights, and the increase in stability due to lower ballast, that she carried over 1,000 feet more sail than the larger yacht, spreading 12,640 square feet. The main boom reached far over the taffrail, being 106 feet in length over all. The hoist was 7 1-2 feet greater and the forward measurement from mast to end of bowsprit had increased to over 73 feet.

When the "Defender" commenced her trials it began to be evident that in the development of the 90-foot racing yacht the limit, not merely of convenience but of actual safety, had been passed. The draft of 19 feet was in itself prohibitive of the use of the boat as a cruiser, since it shut her out from many of the harbors and desirable anchorages, while the experience of the boat in fresh to moderate breezes was marked by breakdowns which, on one occasion, came very near to being disastrous. In some races, when the wind breezed up, rivets were sheared off and the climax came when in a bit of a squall the pull of the weather shrouds was so great that the mast came very near punching a hole for itself through the bottom of the boat. Herreshoff evidently had overlooked the fact that, in cutting into the keel until its forward edge was aft of the mast-step, he had left nothing but the light floor-plates and the frail plating to take the enormous downward thrust of the mast. Emergency repairs were at once made by carrying a pair of ½-inch by 8-inch steel straps from the toot of the mast up to a junction with the chain-plates at the deck. Trouble was also experienced in keeping the bowsprit from coming inboard; several of the frames of the boat broke at the turn of the garboards; and from first to last the extreme lightness of the craft was a source of unceasing anxiety to her owners.

Four years later the Bristol yard turned out "Columbia," a yacht that embodied some of those features of hull and sail-plan which experience in the smaller classes had shown to be conducive to high speed. She had a foot more depth, or 20 feet; her overhangs, forward and aft, were carried out until on a water-line length of 89 feet 7 1-8 inches she had an over-all length of about 50 per cent more, or 132 feet. Although a 90-footer when at anchor she was a 115-footer when heeled to her sailing lines, the great increase in the overhangs being due to the effort to build the biggest possible boat on the arbitrary so-called 90-foot length. The enlargement of the sail-plan was chiefly in the direction of greater hoist, the distance from main boom to topmast sheave being 138 1-2 feet. The disastrous experience with "Defender" showed the absolute necessity of using more reliable materials in the hull, which was constructed of Tobin bronze plating on steel frames. The hull structure proved satisfactory, but the lightening up of the spars and standing rigging had been carried too far, as shown by the fact that in her trial races she carried away her mast.

Two years later, to meet "Shamrock II.," Herreshoff brought out the "Constitution," which differed in form from "Columbia" merely by an increase of one foot in the beam. The sail-plan was greater than that of "Columbia" by about 1,200 square feet. The hoist had now increased to 142 feet, the boom to 110 feet, and the base of the forward triangle to 78 feet. "Constitution's" appearance is comparable only to that of "Defender" in the constant succession of breakdowns that have occurred; but with this distinction, however, that whereas "Defender's" trouble was in the hull, "Constitution's" has been up aloft. At different times she has carried away her mainmast, her topmast and her gaff. Of the hull, however, it must be admitted that the system of belt-and-longitudinal framing adopted by Herreshoff has been eminently successful. Although it is probable that no large amount of weight is saved over the old system of framing, it is certain that weight for weight it is considerably stronger. "Constitution" proved so much of a disappointment that it was really realized that to defend the cup successfully some radical depar-

ture must be taken, and Herreshoff struck out most boldly in the direction of the "scow" type, which had proved so fast in the smaller classes of yachts. On a water-line of 90 feet the new boat has a beam of over 26 feet, a draft of 20 feet, and an over-all length of close upon 150 feet. Although she is a 90-footer at anchor, she is fully a 120-footer when heeled to a breeze; and to this fact is to be ascribed the astonishing sail-carrying power which she has shown, the area under the New York Yacht Club measurement being 16,247 square feet; and if changes are made they will be rather in the direction of an increase than a reduction of sail-plan. The growth of sail power in the last fifteen years may be summed up in the statement that on an increased water-line length of only 10 feet the "Reliance" of 1903 spreads over twice as much sail as did "Puritan" in 1885. In her we see, unquestionably, the highest possible development under the existing rule, and although the boat is an overgrown monstrosity as a sailing craft, she is certainly a great tribute to her builder, both as a naval architect and as a wonderfully resourceful and ingenious mechanic. She is the biggest, lightest constructed, most powerful, and probably the fastest yacht of her water-line length that ever was or ever will be constructed, and she possesses that dual quality, never before found in one and the same yacht, of being relatively just as fast in light as she is in strong winds.

# CHAPTER III.

## THE NAVIES OF THE WORLD.

The subject of the navies of the world is a most important one. Schemes of classification vary, and it is difficult to obtain any figures which agree. The three English authorities are "The Naval Annual," by T. A. Brassey; "The Naval Pocket Book," by Sir W. Laird Clowes, and F. T. Jane's "All the World's Fighting Ships" (Munn & Co., publishers). The latter is filled with illustrations, diagrams, etc., and has an excellent thumb index, facilitating easy reference. Our comparison of naval strength is based on these three books. In addition, we give the tables of the Hydrographic Office, and for those who care to pursue the matter further, we give an abstract of the section of Hazell's Annual dealing with the subject. With this explanation it is hoped that the dissimilar figures will not be as confusing as they otherwise would be.

### THE CONSTRUCTION AND CLASSIFICATION OF MODERN WARSHIPS.

The modern warship is an ever popular subject with the readers of the illustrated press. This is proved by the tenacity with which guns, ships and armor hold their place as conspicuous subjects for the pen and the brush. It is a question, however, in spite of the familiarity of the public with the technical phraseology of the warship, whether the average reader has a very accurate idea of the distinctions between the various classes of ships and between the various elements from the combination of which these ships derive their distinctive class characteristics. He is told that the "Indiana" is a battleship, the "Brooklyn" an armored cruiser, the "Columbia" a protected cruiser, and the "Puritan" a monitor. But it is probable that he has only a vague idea as to what qualities they are that mark the distinction, or why the distinctions should need to exist at all.

With a view to answering these questions in a general way, we have prepared three diagrams and a perspective drawing which show the constructive features of the several types of warship to which we have referred above. In diagrams I to III the armor is indicated by full black lines or by shading, the approximate thickness of the armor being shown by the thickness of the lines and the depth of the shading. The fine lines represent the unarmored portions of the ordinary plating of the ships. In the end view the armor is shown by full lines and shading and the ordinary ship plating by dotted lines.

When the naval architect sits down at his desk to design a warship of a certain size, he knows that there is one element of the vessel which is fixed and unalterable, and that is her displacement. By displacement is meant the actual weight of the ship, which is, of course, exactly equal to the weight of water which she displaces. This total weight is the capital with which the architect has to work, and he uses his judgment in distributing it among the various elements which go to make up the ship. Part is allotted to the hull, part to the motive power, part to the armor protection, part to the guns, and part to the fuel, stores, furnishing and general equipment.

It is evident that the allotment of weights is a matter of compromise—whatever excess is given to one element must be taken from another; else, the ship will exceed the given displacement. Among the elements above mentioned there are some, such as weight of hull, provisions, stores, and furnishings, which for a given size of ship will not vary greatly.

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| ENGLAND, | FRANCE, | GERMANY, | UNITED STATES, | ITALY, | JAPAN, | RUSSIA, | AUSTRIA, |
|---|---|---|---|---|---|---|---|
| 1,595,871 tons. | 603,721 tons. | 441,249 tons | 316,523 tons. | 254,510 tons. | 252,661 tons. | 224,237 tons. | 112,336 tons. |

COMPARATIVE STRENGTH OF THE WORLD'S NAVIES IN COMPLETED SHIPS.

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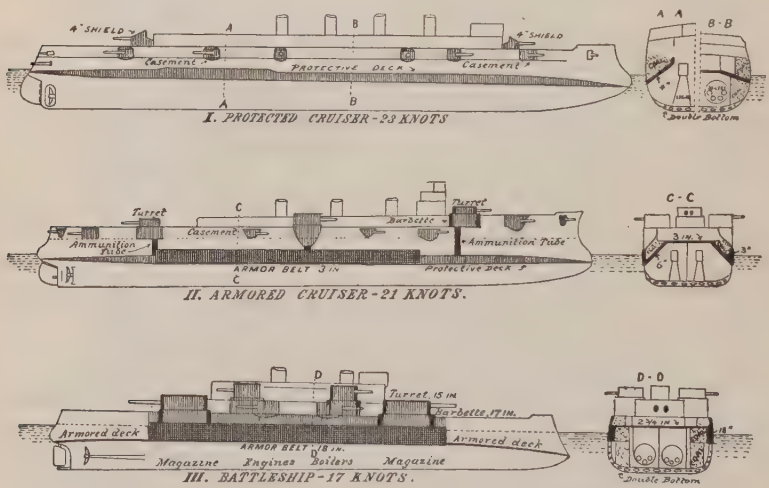
RUSSIA. 1904 JAPAN. RUSSIA. 1905 JAPAN.

COMPARATIVE SIZE OF THE RUSSIAN AND JAPANESE NAVIES IN 1904 AND IN JULY, 1905.

There are other elements, such as guns, armor, engines and fuel-supply, which may vary considerably in different ships, according to the type of vessel that is produced. If, for instance, the architect is designing an extremely fast ship of type No. 1, which has a speed of 23 knots, he will have to allot such a large amount of weight to the motive power that he will only be able to give the ship very slight armor protection and a comparatively light battery of guns. If he wishes to produce a fast ship that shall be more heavily armed and armored, he has to besides protecting his water line in the region of the engines and boilers with a belt of steel of the same dimensions.

The swift and lightly armed and armored ship is known as a protected cruiser; the less speedy but more heavily armed and armored ship belongs to the armored cruiser type, and the slowest ship, with its capacity for taking and giving the heaviest blows that modern guns can inflict, is known as a battleship.

In the construction of a warship the two qualities of attack and defense have to be supplied. The offen-

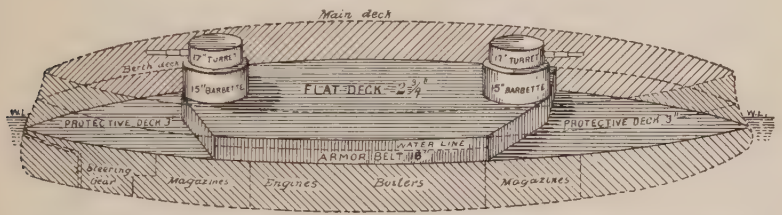



COMPARATIVE ARMOR PROTECTION IN PRINCIPAL TYPES OF MODERN WAR VESSELS.

be content with less speed, say 20 or 21 knots, as in No. 2, and the weight so saved on the motive power appears in the shape of a side belt of armor at the water line, more complete protection for the guns in the shape of barbettes and turrets and considerably heavier armament. If, again, he desires to produce a ship capable of contending with the most powerful ships in line of battle, as in No. 3, he is content with much lower speed, say 16 or 17 knots an hour, and he increases the power of his guns until they weigh over 60 tons apiece, and protects them with great redoubts and turrets of steel 1 1-2 feet thick, sive powers are furnished by the guns, the torpedoes and the ram; the defensive powers are provided by giving the ship a complete double bottom and an abundance of watertight compartments, and by providing it with as much armor plating as it will carry to keep out the shells of the enemy. The greatest danger to which a warship is exposed is that of being sunk either by under-water attack by torpedoes or the ram, or by being penetrated at the water line by heavy shell fire. The destructive force of a torpedo is so great that all that can be done is to localize its effects. For this purpose, and also to give greater structural

strength, the hull below the water line is built double—a hull within a hull. The longitudinal and transverse plate framing of the ship is built in between these shells, which are known as the inner and outer bottoms, and the space is thus divided into innumerable watertight compartments or cells. There is a possibility that a blow that would burst in the outer shell might not rupture the inner shell; but if it should, the inflow of water is confined to a limited portion of the hull by dividing the latter by transverse and longitudinal walls or bulkheads of plating. A blow that burst in both outer and inner shells would only admit water to one of many compartments, and the ship would still have a large reserve of buoyancy.

In protecting warships against shell fire it is recognized that there are




(All parts above the water lines shown by dotted lines and light shading, might be shot away without destroying the fighting power of the ship.)

THE INVULNERABLE, FLOATING FORT, WITHIN THE OUTER WALLS OF A MODERN BATTLESHIP.

certain parts of the ship which are of paramount importance, inasmuch as their disablement would leave it at the mercy of the enemy. These are the "vitals" of the ship, and they comprise the magazines, the boilers, the engines and the steering gear. If a shell penetrated the magazines, it would be liable to result in the blowing up of the whole ship, and if it entered the boiler, engine or steering rooms, it would probably render the ship unmanageable, in which event she would run the risk of being rammed and sunk by the enemy.

In all warships the vitals are covered by a complete protective deck of steel, which varies in thickness from 1 1-2 to 3 inches. The highest part of the deck is generally at a slightly higher level than the water line amidships, and it curves down at each end to meet the bow and the stern. In the battleship this deck is generally flat from side to side amidships for about two-thirds of the ship's length. At the sides it rests upon a wall of vertical armor from 15 to 18 inches in thickness, which extends in the wake of the magazines, engines and boilers. This side armor is usually about 7 1-2 feet in height, 3 feet of it being above and 4 1-2 feet below the water line. At each end of the side armor a transverse wall of armor extends clear across the ship. This rectangular wall with its roof of 3-in. steel thus forms a kind of inverted box, snugly sheltered below which are the before mentioned "vitals" of the ship. At each end of this inverted box two huge barbettes, with walls 15 to 17 inches thick, are built up to a few feet above the main deck, and just within and above them revolve a pair of turrets with walls of 15 to 17 inch steel. (See perspective view.) The turrets give shelter to the big guns, of which there are a pair in each, and the barbettes protect the turning gear by which the turrets are rotated. There is thus a continuous wall of 15 to 17 inch steel extending from 4 feet below the water line to the roofs of the turrets.

With this description in mind the reader will see, on looking at diagram No. III., that before heavy shells can injure the engines, boilers or guns, they must pass through from 15 to 18 inches of solid and, in the case of American battleships, face-hardened Harvey steel. The 6-inch and 8-inch guns are protected by 6 and 8 inches of steel.

Now it can readily be understood that all this amount of heavy armor and guns adds greatly to the weight of the ship, and for this reason, in

spite of her smaller engine power, a firstclass battleship rarely displaces less than 10,000 tons, and in some foreign navies the displacement runs up to nearly 16,000 tons. This will be understood by reference to the perspective view, where the armored portions of the ship are indicated by full lines and shading. It will be seen that all that part of the ship lying below the water line is shut in by a continuous roof of steel which is 3 inches in thickness forward and aft of the bulkheads. Over the central armored citadel it is 2 3-4 inches thick. All the plating indicated by dotted lines might be shot away without the "vitals" suffering injury or the ship being sunk. The reader will see that it is the battleship's sides and the extra deck and freeboard which they provide which constitute practically the difference between a battleship and a monitor.

This brings us to the consideration of the monitor type. Take away from a battleship all that portion which is shown in our drawing in shaded lines above the water line; lower the barbettes until they rise only a few feet above the steel deck, and we have a ship of the general monitor type. The monitor is distinguished by very low freeboard—only a few inches in the extreme type—the absence of a heavy secondary battery and the possession of a main armament of heavy guns. Such a ship labors heavily in bad weather and is not intended for service at any distance from the coasts. To make a seagoing vessel out of her it would be necessary to add one, or even two decks, placing the guns well up above the water, after which changes she would be no longer a monitor, but a seagoing battleship.

In the cruiser type the protective deck does not extend across the ship at one level, but curves down to meet the hull at a point several feet below the water line. This sloping portion is made thicker than the flat portion, as in diagram No. II., where the deck is 3 inches thick on the flat and 6 inches on the slopes. In the case of the armored cruisers, a belt of vertical armor is carried at the water line and in all cruisers the V-shaped space between belt and sloping deck is filled in with coal or with some form of water-excluding material, such as cornpith cellulose. In diagram II., which represents the fine armored cruiser "Brooklyn," it will be seen that before it could reach the engine room a shell would have to pass through 3 inches of vertical steel, about 6 feet of coal and 6 inches of inclined armor—a total resistance equal to 14 or 15 inches of solid steel. The guns and turning gear are protected by 5 1-2-inch steel turrets and 8-inch barbettes. The barbettes, it will be seen, do not extend continuously down to the armored deck, as in the battleship, for this would require a greater weight of armor than can be allowed. Consequently, the architect is only able to furnish the guns with a small armor-plated tube for protecting the ammunition in its passage from the magazines to the barbettes.

In the protected cruiser the side armor at the water line disappears altogether, and dependence is placed entirely upon the sloping sides of the protective deck, the water-excluding cellulose and the 6 or 8 feet of coal which is stowed in the bunkers in the wake of the engines and boilers. The barbettes, turrets and armored ammunition tubes of the armored cruiser disappear, and their place is taken by comparatively light shields and casements of 4-inch steel which serve to protect the gun crews.

It will be seen from the above description that each class of vessel is only fitted to engage ships of its own type. The protected cruiser "Columbia" (No. I.) might, with her light 6 and 4 inch guns, hammer away all day at the "Indiana" (No. III.) without being able to do much more than knock the paint off the latter's 18-inch armor, whereas one well-directed shot from the 13-inch guns of the "Indiana" would be sufficient to sink or disable the "Columbia." The "Brooklyn" would fare better, and at close range her 8-inch guns might happen to penetrate the belt or turret armor of the "Indiana," but the issue of the duel would never be in doubt for an instant. A "Columbia" or a "Brooklyn" would show its heels to an "Indiana" or "Massachusetts," and their great speed would give them the option of refusing or accepting battle with almost any craft that is afloat upon the seas to-day.

It should be mentioned, in conclusion, that the dividing lines in the classification of warships are somewhat flexible.

## RELATIVE STRENGTH IN MATERIEL: PRINCIPAL NAVIES.

A Parliamentary Return dated March 26th, 1903, was issued in May of that year, showing the Fleets of Great Britain, France, Russia, Germany, Italy, the United States of America, and Japan. This return is here brought up to date Nov. 13th, 1904. This refers to the text matter.—*Hazell's Annual.*

The figures in the tables show the condition of affairs on June 3, 1905; since this time the Russo-Japanese war shows great changes. The severe losses of the Russians and the slight losses of the Japanese have been taken into account in the tables. The third, fourth and fifth tables are issued by the Office of Naval Intelligence, U. S. N., with modifications, occasioned by the Russo-Japanese War.

### BUILT.

| Type. | Great Britain. | France. | Germany. | Italy. | United States. | Japan. | Russia. |
|---|---|---|---|---|---|---|---|
| Battleships, 1st class | 54 | 20 | 16 | 14 | 12 | 4 | 7 |
| " 2nd class | 4 | 9 | 4 | — | 1 | 1 | |
| " 3rd class | 2 | 1 | 12 | 3 | — | — | 1 |
| Coast defence vessels | 1 | 14 | 11 | — | 11 | 2 | 7 |
| Cruisers, armored | 29 | 18 | 4 | 5 | 2 | 8 | 3 |
| " protected, 1st class | 21 | 7 | 1 | — | 3 | — | 4 |
| " " 2nd class | 50† | 16 | 8 | 5 | 17 | 21 | 4 |
| " " 3rd class | 34† | 17 | 14 | 13‡ | 2 | | 8 |
| " unprotected | 8 | 1 | 20 | 1 | 7 | | 7 |
| Torpedo vessels | 32 | 15 | 2 | 14 | — | 1 | 8 |
| Torpedo-boat destroyers | 131 | 31 | 37 | 11 | 20 | 19 | 33 |
| Torpedo boats | 87 | 233 | 86 | 138 | 31 | 85 | 82 |
| Submarines | 8 | 26 | 1 | 1 | 8 | — | 13 |

### BUILDING.

| Type. | Great Britain. | France. | Russia. | Germany. | Italy. | United States. | Japan. |
|---|---|---|---|---|---|---|---|
| Battleships, 1st class | 5<br>2* | 6 | 6 | 6 | 4<br>1* | 12<br>4* | 2 |
| Cruisers, armored | 13<br>4* | 5<br>1* | — | 3 | 1 | 8<br>2* | — |
| " protected, 1st class | — | — | 2 | — | — | 3 | — |
| " " 2nd class | 1 | — | — | — | — | — | 1 |
| " " 3rd class | 2 | — | — | 3<br>3* | — | — | — |
| Scouts | 8 | 3* | — | — | — | 3* | — |
| Torpedo-boat destroyers | 15<br>14* | 2<br>6 | 40 | 6 | 2 | 6* | 1 |
| Torpedo boats | 4 | 20<br>74* | 24§ | — | 8<br>14* | 1<br>6* | 3 |
| Submarines | 11<br>10* | 14<br>34* | 13§ | — | 3<br>4* | — | — |

## RELATIVE ORDER OF WAR SHIP STRENGTH.

| At Present. | | As would be the Case were Vessels Building now Completed. | |
|---|---|---|---|
| Nation. | Tonnage. | Nation. | Tonnage. |
| Great Britain | 1,595,871 | Great Britain | 1,926,107 |
| France | 603,721 | France | 778,149 |
| Germany | 441,249 | United States | 643,693 |
| United States | 316,523 | Germany | 567,291 |
| Italy | 254,510 | Russia | 335,085 |
| Japan | 252,661 | Italy | 327,339 |
| Russia | 224,237 | Japan | 288,061 |
| Austria | 112,336 | Austria | 151,426 |

* Signifies programme 1904-5 (ordered or projected).
† Including one partially protected.
‡ Including two partially protected.
§ It is not certain whether all these have been actually commenced.

## SEA STRENGTH OF THE PRINCIPAL NAVAL POWERS.

JUNE 3, 1905.

NUMBER AND DISPLACEMENT OF WAR SHIPS, BUILT AND BUILDING, OF 1,000 OR MORE TONS AND OF TORPEDO CRAFT OF MORE THAN 50 TONS.

| Type of Vessel. | Great Britain. | | | | France. | | | | Russia. | | | | Germany. | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Built. | | Building. | | Built. | | Building. | | Built. | | Building. | | Built. | | Building. | |
| | No. | Tons. | No. | Tons. | No. | Tons. | No. | Tons. | No. | Tons. | No. | Tons. | No. | Tons. | No. | Tons. |
| Battleships, first class * | 51 | 682,200 | 8 | 130,800 | 19 | 212,589 | 6 | 87,800 | 7 | 82,809 | 5 | 72,182 | 16 | 178,575 | 6 | 77,982 |
| Coast defense vessels † | 6 | 49,900 | .... | ..... | 17 | 73,368 | .... | ..... | 7 | 43,391 | .... | ..... | 16 | 91,315 | .... | ..... |
| Armored cruisers | 29 | 282,400 | 12 | 146,400 | 18 | 145,085 | 6 | 73,491 | 3 | 31,288 | .... | ..... | 4 | 39,047 | 3 | 28,044 |
| Cruisers above 6,000 tons ‡ | 21 | 201,950 | .... | ..... | 4 | 31,513 | .... | ..... | 4 | 25,911 | 2 | 13,290 | .... | ..... | .... | ..... |
| Cruisers, 6,000 to 3,000 tons‡ | 50 | 221,460 | 7 | 23,880 | 18 | 74,378 | .... | ..... | 3 | 12,593 | .... | ..... | 9 | 46,749 | .... | ..... |
| Cruisers, 3,000 to 1,000 tons‡ | 56 | 103,960 | 6 | 17,650 | 18 | 32,868 | .... | ..... | 7 | 8,760 | 1 | 1,316 | 27 | 58,859 | 6 | 17,712 |
| Torpedo boat destroyers | 126 | 44,565 | 17 | 8,730 | 31 | 9,250 | 8 | 2,576 | 33 | 10,000 | 53 | 22,680 | 37 | 12,660 | 6 | 2,064 |
| Torpedo boats | 90 | 8,036 | 4 | 776 | 238 | 20,735 | 73 | 7,081 | 82 | 8,000 | 6 | 840 | 105 | 13,924 | .... | ..... |
| Submarines | 9 | 1,400 | 10 | 2,000 | 37 | 3,935 | 15 | 3,480 | 13 | 1,485 | 12 | 1,380 | 1 | 120 | 2 | 240 |
| Total tons built and total tons building | .... | 1,595,871 | .... | 330,236 | .... | 603,721 | .... | 174,428 | .... | 224,237 | .... | 110,848 | .... | 441,249 | .... | 126,042 |
| Total tons built and building | | 1,926,107 | | | | 778,149 | | | | 335,085 | | | | 567,291 | | |

| Type of Vessel. | United States. | | | | Italy. | | | | Japan. | | | | Austria. | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Built. | | Building. | | Built. | | Building. | | Built. | | Building. | | Built. | | Building. | |
| | No. | Tons. | No. | Tons. | No. | Tons. | No. | Tons. | No | Tons. | No. | Tons. | No. | Tons. | No. | Tons. |
| Battleships, first class* | 12 | 137,329 | 12 | 180,200 | 13 | 162,314 | 5 | 62,325 | 5 | 70,516 | 2 | 32,400 | .... | ..... | 3 | 31,800 |
| Coast defense vessels† | 12 | 47,445 | .... | ..... | 1 | 3,913 | .... | ..... | 5 | 29,527 | .... | ..... | 11 | 74,150 | .... | ..... |
| Armored cruisers | 2 | 17,415 | 8 | 111,800 | 5 | 31,891 | 1 | 7,294 | 8 | 72,738 | .... | ..... | 2 | 11,520 | 1 | 7,300 |
| Cruisers above 6,000 tons‡ | 2 | 14,750 | 3 | 28,800 | .... | ..... | .... | ..... | .... | ..... | .... | ..... | .... | ..... | .... | ..... |
| Cruisers, 6,000 to 3,000 tons‡ | 16 | 58,279 | 1 | 3,100 | 5 | 17,490 | .... | ..... | 11 | 42,596 | 1 | 3,000 | 2 | 8,128 | .... | ..... |
| Cruisers, 3,000 to 1,000 tons‡ | 21 | 29,497 | 2 | 2,170 | 12 | 26,216 | .... | ..... | 11 | 21,276 | .... | ..... | 8 | 15,260 | .... | ..... |
| Torpedo boat destroyers | 16 | 6,695 | .... | ..... | 11 | 3,503 | 2 | 650 | 22 | 7,426 | .... | ..... | .... | ..... | .... | ..... |
| Torpedo boats | 27 | 4,200 | 5 | 1,100 | 101 | 9,076 | 14 | 1,960 | 81 | 7,317 | .... | ..... | 37 | 3,278 | .... | ..... |
| Submarines | 8 | 913 | .... | ..... | 1 | 107 | 6 | 600 | 11 | 1,265 | .... | ..... | .... | ..... | .... | ..... |
| Total tons built and total tons building | .... | 316,523 | .... | 327,170 | .... | 254,510 | .... | 72,829 | .... | 252,661 | .... | 35,400 | .... | 112,336 | .... | 39,100 |
| Total tons built and building | | 643,693 | | | | 327,339 | | | | 288,061 | | | | 151,436 | | |

* Battleships, first class, are those of (about) 10,000 or more tons displacement.

† Includes smaller battleships and monitors.

‡ All unarmored war ships of more than 1,000 tons are, in this table, classed according to displacement as cruisers. Scouts are considered as cruisers in which battery and protection have been sacrificed to secure extreme speed. The word "protected" has been omitted because all cruisers except the smallest and oldest now have protective decks.

N.B.—The following vessels are not included in the tables. Those over twenty years old, unless they have been reconstructed and rearmed. Those not actually begun, although authorized. Gunboats and other vessels of less than 1,000 tons. Transports, colliers, repair ships, torpedo depot ships, converted merchant vessels or yachts. Torpedo craft of less than 50 tons. Gunboats of less than 1,000 tons have so slight a military value as a part of the fleet that they are omitted

NUMBER OF TORPEDO VESSELS AND SUBMARINES, BUILT AND BUILDING.

| TYPE. | Great Britain. | | France. | | Russia. | | Germany. | | United States. | | Italy. | | Japan. | | Austria. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Built. | Building. | Built. | Building. | Built. | Building. | Built. | Building. | Built. | Building. | Built. | Building. | Built. | Building. | Built. | Building. |
| Torpedo boat destroyers | 139 | 3 | 31 | 28 | 37 | 3 | 43 | 18 | 16 | .. | 15 | 16 | 20 | 28 | .. | 1 |
| Torpedo boats | 199 | .. | 295 | 89 | 130 | 4 | 102 | ? | 34 | 2 | 193 | .. | 73 | ? | 68 | 1 |
| Submarines | 18 | 21 | 38 | 9 | 4 | .. | 1 | 5 | 8 | 4 | 2 | 7 | 13 | ? | ? | ? |
| Totals | 356 | 24 | 364 | 126 | 161 | 7 | 146 | 23 | 58 | 6 | 160 | 23 | 106 | 28 | 68 | 2 |
| Combined totals | 380 | | 490 | | 168 | | 169 | | 64 | | 183 | | 134 | | 70 | |

# THE NAVIES OF THE WORLD IN DETAIL.

## ARGENTINE REPUBLIC.

Personnel.—There are 321 executive officers and 158 engineer officers on the active list, and from 5,000 to 6,000 men. The executive officers are divided as follows: 1 vice-admiral, 2 rear-admirals, 3 commodores, 11 captains, 42 commanders, 30 lieutenants, 91 sub-lieutenants, 81 midshipmen, and 60 cadets.

Materiel.—The strength in ships built and building on Nov. 30th, 1903 was:—

BUILT.

| | |
|---|---|
| Battleships | 1 |
| Coast defence vessels | 4 |
| Armored cruisers | 4 |
| Protected cruisers | 5 |
| Torpedo vessels | 5 |
| Torpedo-boat destroyers | 3 |
| Torpedo boats | 22 |

BUILDING.

| | |
|---|---|
| *Armored cruisers | 2 |

Dockyards.—The principal dockyards are situated as follows:—

San Fernando.—Three small docks take cruisers.

Puerto Belgrano.—One large dock takes battleships.

Buenos Ayres.—Very limited accommodation.

## AUSTRIA-HUNGARY.

Personnel.—The number of all ranks in the Austrian Navy, including reserves, is 10,841. The officers of the Austrian Navy are distributed as follows: 1 admiral, 2 vice-admirals, 17 captains, 27 commanders, 37 lieutenant-commanders, 200 lieutenants, 191 sub-lieutenants, and 180 midshipmen.

Materiel.—The strength in ships built, building, and projected on Nov. 30th, 1903, was:—

BUILT.

| | |
|---|---|
| Battleships, 3rd class | 5 |
| Coast defence ships | 3 |
| River monitors | 4 |
| Armored cruisers | 1 |
| Protected cruisers, 2nd class | 2 |
| " " 3rd class | 4 |
| Torpedo vessels | 15 |
| Torpedo boats | 37 |

BUILDING.

| | |
|---|---|
| Battleships, 1st class | 4 |
| Monitors | 2 |
| Armored cruisers | 1 |
| Torpedo vessels | 5 |

Dockyard.—The principal Government dockyard of Austria-Hungary is situated at Pola. There are three small docks there.

*These two vessels are the *Bernadino Rivadavia* and the *Mariano Moreno*, which were built in Italy, and were sold (Dec. 31st, 1903) to the Japanese Government.

## BRAZIL.

PERSONNEL.—The personnel of the Brazilian navy numbers about 8,500 of all ranks. The executive officers are distributed as follows: 1 admiral, 2 vice-admirals, 10 rear-admirals, 18 captains, 30 commanders, 60 lieutenant-commanders, 175 lieutenants, and 160 sub-lieutenants.

MATERIEL.—The ships built for the Brazilian Navy number in all 63. There are no vessels under construction.

BUILT.

| | |
|---|---|
| Coast defence ships | 9 |
| Protected cruisers | 6 |
| Torpedo vessels | 18 |
| Torpedo boats | 28 |
| Submarines | 2 |

DOCKYARDS.—The only important dockyard is situated at Rio de Janeiro, where there are three docks to take cruisers, and two smaller ones. Besides this there are naval bases at Para, Bahia, Pernambuco, and Ladario de Matto Grosso.

## CHILE.

PERSONNEL.—The numbers of officers and men on the active list are variously stated to be from 6,000 to 8,000. The executive officers are distributed as follows: 1 vice-admiral, 4 rear-admirals, 11 captains, 18 commanders, 16 lieutenant-commanders, 25 lieutenants, and 36 midshipmen.

MATERIEL.—The strength in ships built and building on Nov. 30th, 1903, was:—

BUILT.

| | |
|---|---|
| Battleships | 2 |
| Armored cruisers | 2 |
| Protected cruisers | 6 |
| Torpedo vessels | 5 |
| Torpedo-boat destroyers | 6 |
| Torpedo boats | 24 |

DOCKYARDS.—The principal dockyards are situated as follows:—

Talcahuno.—One dock takes any warship.

Valparaiso.—Two small floating docks take cruisers.

## DENMARK.

PERSONNEL.—The personnel numbers about 4,000 of all ranks. The executive officers are divided as follows: 1 vice-admiral, 2 rear-admirals, 16 captains, 38 commanders, 63 lieutenants, 33 sub-lieutenants, and 23 midshipmen.

MATERIEL.—The strength in ships built and building on Nov. 30th, 1903, was:—

BUILT.

| | |
|---|---|
| Battleships | 4 |
| Coast defence vessels | 4 |
| Protected cruisers | 5 |
| Torpedo boats | 25 |

BUILDING.

| | |
|---|---|
| Coast defence vessel | 1 |

DOCKYARD.—At Copenhagen there are three small docks.

## FRANCE.

PERSONNEL.

The number of officers and men on the active list of the French Navy in 1903 was 53,247, and in the Reserve there were 49,346 officers and men. The number of men effective during 1903 was less by 2,940 than the number available during the preceding year.

The executive officers of the French Navy are divided as follows:—15 vice-admirals, 30 rear-admirals, 124 captains, 212 commanders, 751 lieutenant-commanders, 574 lieutenants, 146 sub-lieutenants, 100 midshipmen, 183 cadets.

MATERIEL.

The number of ships built, building, and projected for the French Navy on Nov. 30th, 1903, was:—

BUILT.

| | |
|---|---|
| Battleships, 1st class | 20 |
| " 2nd class | 9 |
| " 3rd class | 1 |
| Coast defence vessels | 14 |
| Armored cruisers | 10 |
| Protected cruisers, 1st class | 7 |
| " " 2nd class | 16 |
| " " 3rd class | 17 |
| Unprotected cruisers | 1 |
| Torpedo vessels | 16 |
| Torpedo-boat destroyers | 14 |
| Torpedo boats | 247 |
| Submarines | 15 |

BUILDING.

| | |
|---|---|
| Battleships, 1st class | 6 |
| Armored cruisers | 12 |
| Torpedo-boat destroyers | 19 |
| Torpedo-boats | 18 |
| Submarines | 25 |

PROJECTED.

| | |
|---|---|
| Armored cruiser* | 1 |
| Torpedo-boat destroyers | 4 |
| Torpedo boats | 25 |
| Submarines | 18 |

DOCKYARDS.

The Government dockyards in France are situated as follows:—

Cherbourg.—One dock takes battleships 14,000 tons; seven smaller.

Brest.—One dock takes battleships; others very small.

Lorient.—One dock takes battleships 14,000 tons; one takes small cruisers.

Rochefort.—Three docks, take small vessels only.

Toulon.—Three docks take battleships 14,000 tons; six others take cruisers.

## GERMANY.

PERSONNEL.

The number of officers and men on the active list is 35,685, and on the regular reserve there are 5,114. The total number of able-bodied men liable for service in the Reserve, however, is about 70,000.

*This armored cruiser is the *Ernest Renan* of 13,562 tons.

The executive officers of the German Navy are divided as follows:—8 vice-admirals, 16 rear-admirals, 58 captains, 125 commanders, 245 lieutenant-commanders, 382 lieutenants, 332 sub-lieutenants, 401 midshipmen, 200 cadets.

MATERIEL.

The strength of the German Navy in ships built and building on Nov. 30th, 1903, was:—

BUILT.

| | |
|---|---|
| Battleships, 1st class | 14 |
| " 2nd class | 4 |
| " 3rd class | 12 |
| Coast defence ships | 11 |
| Armored cruisers | 2 |
| Protected cruisers, 1st class | 1 |
| " " 2nd class | 8 |
| " " 3rd class | 10 |
| Unprotected cruisers | 20 |
| Torpedo vessels | 2 |
| Torpedo-boat destroyers | 32 |
| Torpedo boats | 93 |
| Submarines | ? |

BUILDING.

| | |
|---|---|
| Battleships, 1st class | 6 |
| Armored cruisers | 3 |
| Protected cruisers, 3rd class | 5 |

PROJECTED.

| | |
|---|---|
| Armored cruiser* | 1 |
| Protected cruisers | 2 |
| Torpedo-boat destroyers | 6 |
| Torpedo boats | — |
| Submarine | 1 |

DOCKYARDS.

The German dockyards are situated as follows:—

Kiel.—Two docks take any ship. Also two floating docks. Four docks take any ship up to 10,000 tons.

Wilhelmshaven.—One dock takes any ship; one takes up to 10,000 tons. Three floating docks; two new ones building.

## GREAT BRITAIN.

PERSONNEL.

The number of officers, seamen, boys, and marines provided for sea and other services for the year 1903-4 amounts to 127,100, being an increase of 4,600 on the previous year. The strength of the Royal Marines on Jan. 1st, 1903, was 19,579.

The passing of the Naval Forces Act during the year will strengthen the Naval Reserves by increasing its numbers, and by authorizing short-service system in the Navy, on condition that those accepting such employment shall complete a term of seven years in the reserve. The Royal Naval Volunteers authorized by the Act of 1902 have commenced enrolment, and Divisions have been formed at London and Glasgow.

MATERIEL.

The strength of the British Navy in ships built, building, and projected on Nov. 30th, 1903, was:—

BUILT.

| | |
|---|---|
| Battleships, 1st class | 49 |
| " 2nd class | 4 |
| " 3rd class | 2 |
| Coast defence ships | 2 |
| Armored crusiers | 24 |
| Protected cruisers, 1st class | 21 |
| " " 2nd class | 51 |
| " " 3rd class | 32 |
| Unprotected cruisers | 10 |
| Torpedo vessels | 34 |
| Torpedo-boat destroyers | 112 |
| Torpedo boats | 85 |
| Submarines | 5 |

BUILDING.

| | |
|---|---|
| Battleships, 1st class | 7 |
| Armored cruisers | 13 |
| Protected cruisers, 2nd class | 2 |
| " " 3rd class | 4 |
| Scouts | 4 |
| Torpedo-boat destroyers | 19 |
| Torpedo boats | 5 |
| Submarines | 4 |

PROJECTED.

| | |
|---|---|
| Battleships, 1st class | 6 |
| Armored cruisers | 4 |
| Protected cruisers | 3 |
| Scouts | 4 |
| Torpedo-boat destroyers | 15 |
| Submarines | 10 |

Two of the first-class battleships are those purchased from Chile.

DOCKYARDS.

The public dockyards in Great Britain are situated as follows:—

Portsmouth.—Six docks take any ship; three take armored cruisers, 10,000 tons and smaller.

Devonport.—Two docks take battleships; two smaller.

Keyham.—One dock takes small battleships; three smaller.

Chatham.—Six docks take battleships (four small ones only); four smaller.

Sheerness.—Five small docks.

Pembroke.—One dock takes small battleships.

Haulbowline.—Two docks take any ship.

## ITALY.

PERSONNEL.

There are 26,948 officers and men on the active list for the current financial year, and the reserve numbers 33,667 officers and men. This latter is, however, of doubtful efficiency, for many of the officers are over sixty-five years of age, and the men have but little training.

The executive officers of the Italian Navy are divided as follows:—1 admiral, 7 vice-admirals, 14 rear-admirals, 58 captains, 70 commanders, 75 lieutenant-commanders, 410 lieutenants, 160 sub-lieutenants, 130 midshipmen.

MATERIEL.

The strength of ships built, building and projected on Nov. 30th, 1903, was:—

BUILT.

| | |
|---|---|
| Battleships, 1st class | 12 |
| " 3rd class | 5 |
| Armored cruisers | 5 |
| Protected cruisers, 2nd class | 5 |
| " " 3rd class | 11 |
| Torpedo vessels | 14 |
| Torpedo-boat destroyers | 11 |
| Torpedo boats | 145 |
| Submarines | 1 |

BUILDING.

| | |
|---|---|
| Battleships, 1st class | 6 |
| Armored cruisers | 1 |
| Submarines | 1 |

PROJECTED.

| | |
|---|---|
| Battleships, 1st class | 3 |
| Protected cruisers, 3rd class | 1 |
| Torpedo-boat destroyers | 2 |
| Torpedo boats | 8 |
| Submarines | 1 |

DOCKYARDS.

The Government dockyards of Italy are situated as follows:—

Spezia.—One dock takes any ship; one takes all Italian ships; four smaller.

Venice.—One dock takes cruisers; one smaller. One building to take any ship.

Taranto.—One dock takes any ship.

## JAPAN.

PERSONNEL.

The number of officers and men available for active service is about 31,000. There is also a small reserve of some 4,000.

MATERIEL.

The strength in ships built, building, and projected on Nov 30th, 1903, less loss, was:—

BUILT.

| | |
|---|---|
| Battleships, 1st class | 6 |
| " 2nd class | 1 |
| Coast defence ships | 2 |
| Armored cruisers | 8* |
| Protected cruisers, 2nd class | 10 |
| " " 3rd class | 7 |
| Unprotected cruisers | 9 |
| Torpedo vessels | 1 |
| Torpedo-boat destroyers | 17 |
| Torpedo boats | 63 |

BUILDING.

| | |
|---|---|
| Protected cruisers, 2nd class | 2 |
| " " 3rd class | 1 |
| Torpedo-boat destroyers | 2 |
| Torpedo boats | 18 |

PROJECTED.

| | |
|---|---|
| Battleships,† 1st class | 4 |
| Armored cruisers | 6 |

DOCKYARDS.

The Government dockyards in Japan are situated as follows:—

Yokosuka.—One dock takes any ship; two smaller.

Kure.—One dock takes cruisers.

*Including two vessels, each of 7700 tons displacement and a speed of 20 knots, purchased from the Argentine Government for $7,500,000 (Dec. 31st, 1903).

†The projected vessels have not been named.

## NETHERLANDS.

PERSONNEL.—The total of officers and men enlisted for the navy reaches 11,000, but this figure includes the marine infantry. The executive officers are divided as follows: 1 vice-admiral, 3 rear admirals, 25 captains, 40 commanders, 400 lieutenants and sub-lieutenants, and 200 midshipmen.

MATERIEL.—The strength in ships built, building and projected on Nov. 30th, 1903, was:—

BUILT.

| | |
|---|---|
| Battleships, 3rd class | 2 |
| Coast defence ships | 19 |
| Unprotected cruisers | 11 |
| Torpedo vessels | 12 |
| Torpedo boats | 29 |

BUILDING.

| | |
|---|---|
| Coast defence ships | 2 |
| Torpedo boats | 5 |

PROJECTED.

| | |
|---|---|
| Coast defence ships | 3 |
| Torpedo vessels | 7 |
| Torpedo boats | 2 |
| Submarine (to be purchased) | 1 |

DOCKYARDS.—The principal dockyards are situated as follows:

Helder.—Two docks take cruisers.

Hellevoetsluis.—One dock takes small battleships.

Amsterdam.—Two floating docks take cruisers.

Rotterdam.—Three floating docks take small cruisers.

## NORWAY.

PERSONNEL.—The personnel numbers about 2,000, of which 1,000 are permanent, and the remainder yearly conscripts. The executive officers are divided as follows: 1 rear-admiral, 4 captains, 14 commanders, 28 lieutenant-commanders, 37 lieutenants, 30 sub-lieutenants.

MATERIEL.—The strength in ships built and building on Nov. 30th, 1903, was:—

BUILT.

| | |
|---|---|
| Coast defence vessels | 4 |
| Torpedo vessels | 7 |
| Torpedo boats | 26 |

BUILDING.

| | |
|---|---|
| Coast defence vessel | 1 |
| Torpedo boats | 2 |
| Submarine | 1 |

DOCKYARDS.—The principal dockyards of Norway are situated as follows:—

Horten.—One dry dock takes small battleships.

Christiansand.—One dry dock takes small battleships.

## PORTUGAL.

PERSONNEL.—The number of men in the Portuguese Navy is about 5,000, and, in addition, there are 2 vice-admirals, 5 rear-admirals, 16 captains, 25 commanders, 25 lieutenant-commanders, 80 lieutenants, 110 sub-lieutenants, 37 midshipmen, and 96 cadets. The age for retirement of a vice-admiral is 70 years, rear-admiral 66 years, and other officers 64 years.

MATERIEL.—The strength in ships built and building on Nov. 30th, 1903, was:—

BUILT.

| | |
|---|---|
| Battleship | 1 |
| Unprotected cruisers | 7 |
| Torpedo vessels | 14 |
| Torpedo boats | 11 |

BUILDING.

| | |
|---|---|
| Torpedo vessels | 2 |

DOCKYARD.—There are four small docks at Lisbon.

## RUSSIA.

PERSONNEL.

There are 2,900 officers on the effective list of the Russian Navy, and the number of men is 61,516. In the Reserve there are about 30,000 of all ranks.

The executive officers of the Russian Navy are divided as follows:—1 commander-in-chief (admiral-general), 14 admirals, 24 vice-admirals, 33 rear-admirals, 92 captains, 212 commanders, 850 lieutenants, 400 midshipmen.

MATERIEL.

The strength of the Russian Navy in ships built, building and projected, on Nov. 30th, 1903, less losses, was:—

BUILT.

| | |
|---|---|
| Battleships, 1st class | 12 |
| " 2nd class | 2 |
| " 3rd class | 1 |
| Coast defence ships | 13 |
| Armored cruisers | 6 |
| Protected cruisers, 1st class | 2 |
| " " 2nd class | 4 |
| " " 3rd class | — |
| Unprotected cruisers | 3 |
| Torpedo vessels | 8 |
| Torpedo-boat destroyers | 40 |
| Torpedo boats | 150 |
| Submarines | 0 |

BUILDING.

| | |
|---|---|
| Battleships, 1st class | 6 |
| Armored cruisers | 0 |
| Protected cruisers, 1st class | 2 |
| " " 2nd class | 2 |
| Torpedo-boat destroyers | 6 |
| Torpedo-boats | 7 |
| Submarines | 2 |

PROJECTED.

| | |
|---|---|
| Battleships, 1st class | 6 |
| Armored cruisers | 3 |
| Protected cruisers, 1st class | 2 |

The projected battleships are the *Tchesma*, *Evstafi* and *Ioann Zlatoust*, all of which are reported to have been laid down in the Black Sea yards; and the *Imperator Pavel*, the *Andrei Pervosvannui*, to be built in the St. Petersburg yards. Of the sixth vessel nothing is yet known, nor have the names of the armored cruisers transpired. The protected cruisers are to be of the *Kagul* type.

[The war with Japan has modified all figures of present strength.]

DOCKYARDS.

The principal Russian dockyards are situated as follows:—

Kronstadt.—One dock takes any ship; three smaller.

Libau.—Two docks take any ship.

Sevastopol.—Two docks take any ship.

## SPAIN.

PERSONNEL.—There are 16,700 of all ranks in the Spanish Navy, and 9,000 marines. All these are conscripts. The officers are divided as follows: 1 admiral, 4 vice-admirals, 11 rear-admirals, 22 captains, 47 commanders, 94 lieutenant-commanders, 131 lieutenants, 340 sub-lieutenants, 165 midshipmen, and 100 cadets.

MATERIEL.—The strength in ships built and building on Nov. 30th, 1903, was:—

BUILT.

| | |
|---|---|
| Battleship | 1 |
| Armored cruisers | 2 |
| Protected cruisers | 6 |
| Torpedo vessels | 17 |
| Torpedo-boat destroyers | 4 |
| Torpedo boats | 10 |

BUILDING.

| | |
|---|---|
| Armored cruisers | 2 |
| Protected cruisers | 2 |

DOCKYARDS.—The principal dockyards are situated as follows:—

Cadiz.—Three docks take cruisers.

Cartagena.—One floating dock takes large cruisers.

Bilboa.—One dock takes any Spanish ship; two smaller.

## SWEDEN.

PERSONNEL.—The personnel of the Swedish Navy in 1903 numbered about 7,500 of all ranks. In addition there are about 20,000 yearly conscripts available, but the majority of these are seldom called upon. The officers are divided as follows: 1 vice-admiral, 4 rear-admirals, 6 commodores, 24 captains, 64 commanders, 55 lieutenants, 30 sub-lieutenants.

MATERIEL.—The strength of ships built and building on Nov. 30th was:—

BUILT.

| | |
|---|---|
| Coast defence vessels | 10 |
| Torpedo vessels | 14 |
| Torpedo-boat destroyer | 1 |
| Torpedo boats | 28 |

BUILDING.

| | |
|---|---|
| Battleship | 1 |
| Armored cruiser | 1 |
| Torpedo boats | 3 |
| Submarine | 1 |

DOCKYARDS.—The principal dockyards in Sweden are situated as follows:—

Karlscrona.—Three docks take any Swedish ship; three smaller.

Stockholm.—One dock takes cruisers.

## TURKEY.

PERSONNEL.—There are 31,000 officers and men in the Turkish Navy and 9,000 marines. The officers are divided as follows: 2 admirals, 9 vice-admirals, 16 rear-admirals, 30 captains, 90 commanders, 300 lieutenant-commanders, 250 lieutenants, 200 sub-lieutenants.

MATERIEL.—The strength in ships built and building for the Turkish Navy on Nov. 30th, 1903, was:—

BUILT.

| | |
|---|---|
| Battleships | — |
| Protected cruiser | 1 |
| Torpedo vessels | 6 |
| Torpedo-boat destroyers | 2 |
| Torpedo boats | 25 |
| Submarines | 2 |

BUILDING.

| | |
|---|---|
| Protected cruisers | 5 |
| Torpedo-boat destroyers | 2 |

## UNITED STATES.

ADMINISTRATION.

The President of the United States is *ex-officio* Commander-in-chief of the Navy. As his executive he appoints a Secretary of the Navy, a member of his Cabinet, on a four years' term. He also appoints an Assistant Secretary of the Navy, and these two political officials, who are usually civilians, exercise a general control and supervision of the ten departments or bureaus among which the business is distributed. These departments are very similar to those in the British Admiralty, and they are almost all of them under the direction of naval officers. There are also special boards, mostly departmental, who advise either the Secretary of the Navy or the chiefs of the bureaus on technical points. There is nothing approximating to the headquarters staff which is found in all naval administrations, based on the precedent of the organization of land forces. In this respect the naval administration of the United States and Great Britain differ from almost all the rest. With regard to the estimates, the chiefs of the various bureaus prepare and make annually reports which are published, and in these reports they make recommendations with estimates of cost. The Secretary of the Navy also makes an annual report, summarizing the reports of his subordinates, with his own recommendations, which are submitted to Congress in the shape of Bills, which, being passed by the House of Representatives and the Senate, and approved by the President, become law. The United States Navy is manned by voluntary enlistment.

FINANCE.

The proposed estimates for 1905-6 total $102,866,449, those for 1903-4 having been $79,039,331. It is proposed to devote to new construction the sum of $28,826,860.

PERSONNEL.

The number of officers and men on the effective list of the United States Navy is 29,838, inclusive of 7,000 marines. There is a reserve in course of formation, but it is not yet in working order.

The executive officers of the United States Navy are distributed as follows:—1 admiral, 1 vice-admiral, 21 rear-admirals, 73 captains, 114 commanders, 172 lieutenant-commanders, 350 lieutenants, 100 second-lieutenants, 130 ensigns, 90 naval cadets at sea.

MATERIEL.

The strength in ships of the United States Navy built, building and projected, is separately treated.

DOCKYARDS.

The Government dockyards in the United States are situated as follows:—

New York.—One dock takes any ship; two smaller.

Norfolk, Va.—One dock takes any ship; one smaller.

Mare Island, Cal.—One dock takes any ship.

Boston, Mass.—One small dock.

Portsmouth, N. H.—One small dock.

League Island, Pa.—One large wooden dock.

Washington, D. C.—No dock.

Pensacola, Fla.—Two floating docks.

Puget Sound, Washington.—One floating dock.

—*Hazell's Annual.*

## THE UNITED STATES NAVY.

On January 1, 1905, there were upon the active list, 1 admiral, 26 rear admirals, 86 captains, 122 commanders, 199 lieutenant-commanders, 343 lieutenants, 10 lieutenants junior grade, 173 ensigns, 104 midshipmen, 16 medical directors, 15 medical inspectors, 86 surgeons, 49 passed assistant surgeons, 70 assistant surgeons, 14 pay directors, 15 pay inspectors, 76 paymasters, 30 passed assistant paymasters, 37 assistant paymasters, 23 chaplains, 12 professors of mathematics, 1 secretary to the admiral, 23 naval constructors, 34 assistant naval constructors, 28 civil engineers, 4 assistant civil engineers, 37 chief boatswains, 103 boatswains, 35 chief gunners, 81 gunners, 39 chief carpenters, 45 carpenters, 6 chief sailmakers, 180 warrant machinists, 25 pharmacists, and 27 mates. There were also 822 midshipmen on probation at the Naval Academy at Annapolis, Md.

## REGULATIONS GOVERNING THE ADMISSION OF CANDIDATES INTO THE NAVAL ACADEMY AS MIDSHIPMEN.

### NOMINATION.

The students of the Naval Academy are styled Midshipmen. Two Midshipmen are allowed for each Senator, Representative, and Delegate in Congress, two for the District of Columbia, and five each year from the United States at large. The appointments from the District of Columbia and five each year at large are made by the President. One Midshipman is allowed from Porto Rico, who must be a native of that island. The appointment is made by the President, on the recommendation of the Governor of Porto Rico. The Congressional appointments are equitably distributed, so that in regular course each Senator, Representative, and Delegate in Congress may appoint one Midshipman during each Congress. After June 30, 1913, each Senator, Representative, and Delegate in Congress will be allowed to appoint but one Midshipman instead of two. The course for Midshipmen is six years—four years at the Academy, when the succeeding appointment is made, and two years at sea, at the expiration of which time the examination for final graduation takes place. Midshipmen who pass the examination for final graduation are appointed to fill vacancies in the lower grades of the Line of the Navy and of the Marine Corps, in the order of merit as determined by the Academic Board of the Naval Academy.

"The Secretary of the Navy shall, as soon as practicable after the fifth day of March in each year, notify in writing each Senator, Representative, and Delegate in Congress of any vacancy which may be regarded as existing in the State, District, or Territory which he represents, and the nomination of a candidate to fill such vacancy shall be made upon the recommendation of the Senator, Representative, or Delegate. Such recommendation shall be made by the first day of June of that year, and if not so made the Secretary of the Navy shall fill the vacancy by the appointment of an actual resident of the State, District, or Territory in which the vacancy exists, who shall have been for at least two years immediately preceding his appointment an actual bona fide resident of the State, District, or Territory in which the vacancy exists, and shall have the qualifications otherwise prescribed by law."

(*Act approved March* 4, 1903.)

Candidates allowed for Congressional Districts, for Territories, and for the District of Columbia must be actual residents of the Districts or Territories, respectively, from which they are nominated.

All candidates must, at the time of their examination for admission, be between the ages of sixteen and twenty years. A candidate is eligible for appointment on the day he becomes sixteen, and is ineligible on the day he becomes twenty years of age.

### EXAMINATION.

"*All candidates for admission into the Academy shall be examined, according to such regulations and at such stated times as the Secretary of the Navy may prescribe. Candidates rejected at such examination shall not have the privilege of another examination for admission to the same class unless recommended by the Board of Examiners.*" (*Rev. Stat., Sec.* 1515.)

When any candidate, who has been nominated upon the recommendation of a Senator, Member, or Delegate of the House of Representatives, is found, upon examination, to be physically or mentally disqualified for admission, the Senator, Member, or Delegate shall be notified to recommend another candidate, who shall be examined according to the provisions of the preceding section.

Beginning with the year nineteen hundred and four, but two examinations for admission of Midshipmen to the Academy will be held each year, as follows:

1. The first examination to be held on the third Tuesday in April, under the supervision of the Civil Service Commission, at points given in a list furnished by the Bureau of Navigation, Navy Department, Washington, D. C., who also furnish sample examination papers. Candidates are examined mentally *only* at this examination. All those qualifying mentally who are entitled to appointment in order of nomination will be notified by the Superintendent of the Naval Academy to report at the Academy for physical examination on or about June 10, and if physically qualified will be appointed.

Candidates nominated for the April examination may be examined at Washington, D. C., if so desired, or at any of the places in any State named in the above schedule.

Senators and Representatives are requested, when designating their nominees, to give the place at which it is desired they should be examined if nominated for the April examination.

2. The second and last examination will be held at Annapolis, Md., *only*, on the third Tuesday in June, under the supervision of the Superintendent of the Naval Academy. Candidates are examined mentally at this examination, and all those entitled to appointment will be directed to report for physical examination, as soon as practicable, at the Naval Academy.

Alternates are given the privilege of reporting for examination at the same time with the principal.

No examination will be held later than the third Tuesday in June.

The large number of Midshipmen to be instructed and drilled makes this rule necessary, and it is to the great advantage of the new Midshipmen themselves. The summer months are utilized in preliminary instruction in professional branches and drills, such as handling boats under oars and sails, and in seamanship, gunnery, and infantry drills. These practical exercises form most excellent groundwork as a preparation for the academic course.

The examination papers used in all examinations are prepared at the Naval Academy and the examination marks made by candidates finally passed upon by the officials of the Academy.

Under the law, candidates failing to pass the entrance examination will not be allowed another examination for admission to the same class unless recommended for re-examination by the Board of Examiners.

The Civil Service Commission only conducts the examination of candidates whose names have been furnished by the Navy Department. It is requested that all correspondence relative to the nomination and examination of candidates be addressed to the Bureau of Navigation, Navy Department.

Nominations for examination on the third Tuesday in April should be forwarded to the Bureau ten days prior to the date of examination, as that is the latest date on which arrangements can be made for the examination.

Candidates will be required to enter the Academy immediately after passing the prescribed examination.

*No leave of absence will be granted to Midshipmen of the fourth class.*

Candidates will be examined physically at the Naval Academy by a board composed of three medical officers of the Navy.

Attention will also be paid to the stature of the candidate, and no one *manifestly* under size for his age will be received at the Academy. In the case of doubt about the physical condition of the candidate, any marked deviation from the usual standard of height or weight will add materially to the consideration for rejection. The height of candidates for admission shall not be less than 5 feet 2 inches between the ages of 16 and 18 years, and not less than 5 feet 4 inches between the ages of 18 and 20 years.

Candidates will be examined mentally in punctuation, spelling, arithmetic, geography, English grammar, United States history, world's history, algebra through quadratic equations, and plane geometry (five books of Chauvenet's Geometry, or an equivalent). Deficiency in any one of these subjects may be sufficient to insure the rejection of the candidate.

ADMISSION.

Candidates who pass the physical and mental examinations will receive appointments as Midshipmen, and become students of the Academy. Each Midshipman will be required to sign articles by which he binds himself to serve in the United States Navy eight years (including his time of probation at the Naval Academy), unless sooner discharged.

The pay of a Midshipman is $500 a year, commencing at the date of his admission.

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The cruisers are the light cavalry of the navy. As their name implies, their duty is to cruise the seas, keeping in touch with the enemy's fleets and acting as the "eyes" of the line-of-battle ships. They are also intended for the double duty of attacking an enemy's commerce and defending that of the country whose flag they carry. Fleets of merchant vessels or of transport ships will be "convoyed" by cruisers from port to port.

## LIST OF SHIPS OF THE UNITED STATES NAVY.

[Abbreviations.—*Hull:* S., steel; S. W., steel, wood sheathed; I., iron; W., wood. *Propulsion:* S., screw; T. S., twin screw; Tr. S., triple screw; P., paddle; I.H.P. indicated horsepower.]

### FIRST RATE.

| Name. | Displacement (tons). | Type. | Hull. | I.H.P. | Propulsion. | Guns (main battery). |
|---|---|---|---|---|---|---|
| Alabama | 11,525 | 1st class battleship | S. | 11,366 | T.S. | 18 |
| Brooklyn | 9,215 | Armored cruiser | S. | 18,769 | T.S. | 20 |
| Colorado | 13,780 | do. | S. | 23,000 | T.S. | 18 |
| Illinois | 11,525 | 1st class battleship | S. | 11,366 | T.S. | 18 |
| Indiana | 10,288 | do. | S. | 9,738 | T.S. | 16 |
| Iowa | 11,340 | do. | S. | 12,105 | T.S. | 18 |
| Kearsarge | 11,525 | do. | S. | 11,954 | T.S. | 22 |
| Kentucky | 11,525 | do. | S. | 12,318 | T.S. | 22 |
| Maine | 12,500 | do. | S. | 16,000 | T.S. | 20 |
| Maryland | 13,680 | Armored cruiser | S. | 23,000 | T.S. | 18 |
| Massachusetts | 10,288 | 1st class battleship | S. | 10,403 | T.S. | 16 |
| Missouri | 12,500 | do. | S. | 16,000 | T.S. | 20 |
| New York | 8,200 | Armored cruiser | S. | 17,401 | T.S. | 18 |
| Ohio | 12,500 | 1st class battleship | S. | 16,000 | T.S. | 20 |
| Oregon | 10,288 | do. | S. | 11,111 | T.S. | 16 |
| Pennsylvania | 13,780 | Armored cruiser | S. | 23,000 | T.S. | 18 |
| West Virginia | 13,780 | do. | S. | 23,000 | T.S. | 18 |
| Wisconsin | 11,525 | 1st class battleship | S. | 10,000 | T.S. | 18 |

### SECOND RATE.

| Name. | Displacement (tons). | Type. | Hull. | I.H.P. | Propulsion. | Guns (main battery). |
|---|---|---|---|---|---|---|
| Baltimore | 4,413 | Protected cruiser | S. | 10,064 | T.S. | 12 |
| Buffalo | 6,888 | Cruiser (converted) | S. | 3,600 | S. | 6 |
| Chicago | 5,000 | Protected cruiser | S. | 9,000 | T.S. | 18 |
| Columbia | 7,375 | do. | S. | 18,509 | Tr.S. | 11 |
| Dixie | 6,145 | Cruiser (converted) | S. | 3,800 | S. | 8 |
| Minneapolis | 7,375 | Protected cruiser | S. | 20,862 | Tr.S. | 11 |
| Monadnock | 4,005 | Double-turret monitor. | I. | 3,000 | T.S. | 6 |
| Monterey | 4,084 | Barbette turret, low free-board monitor | S. | 5,244 | T.S. | 4 |
| Newark | 4,098 | Protected cruiser | S. | 8,869 | T.S. | 12 |
| Olympia | 5,870 | do. | S. | 17,313 | T.S. | 14 |
| Prairie | 6,872 | Cruiser (converted) | I. | 3,800 | S. | 8 |
| Puritan | 6,060 | Double-turret monitor. | I. | 3,700 | T.S. | 10 |
| Rainbow | 6,206 | Cruiser (converted) | S. | 1,800 | S. | *12 |
| San Francisco | 4,098 | Protected cruiser | S. | 9,913 | T.S. | 12 |
| Supply | 4,460 | Cruiser (converted) | I. | 1,069 | S. | *12 |
| Texas | 6,315 | 2d class battleship | S. | 8,610 | T.S. | 8 |
| Yankee | 6,888 | Cruiser (converted) | I. | 3,800 | S. | 8 |

### THIRD RATE.

| Name. | Displacement (tons). | Type. | Hull. | I.H.P. | Propulsion. | Guns (main battery). |
|---|---|---|---|---|---|---|
| Adams | 1,375 | Cruiser | W. | 800 | S. | 6 |
| Albany | 3,437 | Protected cruiser | S.W. | 7,500 | T.S. | 10 |
| Alert | 1,020 | Cruiser | I. | 500 | S. | 6 |
| Amphitrite | 3,990 | Double-turret monitor. | I. | 1,600 | T.S. | 6 |
| Annapolis | 1,000 | Composite gunboat | Comp. | 1,227 | S. | 6 |
| Arkansas | 3,214 | Monitor | S. | 2,400 | T.S. | 6 |
| Atlanta | 3,000 | Protected cruiser | S. | 4,030 | S. | 8 |

*Secondary battery.

THIRD RATE—*Continued.*

| Name. | Displacement (tons). | Type. | Hull. | I.H.P. | Propulsion. | Guns (main battery). |
|---|---|---|---|---|---|---|
| Bennington | 1,710 | Gunboat | I. | 3,436 | T.S. | 6 |
| Boston | 3,000 | Protected cruiser | S. | 4,030 | S. | 8 |
| Castine | 1,177 | Gunboat | S. | 2,119 | T.S. | 8 |
| Chattanooga | 3,100 | Protected cruiser | S.W. | 4,700 | T.S. | 10 |
| Cincinnati | 3,213 | ....do | S. | 10,000 | T.S. | 11 |
| Cleveland | 3,100 | ....do | S.W. | 4,700 | T.S. | 10 |
| Concord | 1,710 | Gunboat | S. | 3,405 | T.S. | 6 |
| Denver | 3,100 | Protected cruiser | S.W. | 4,700 | T.S. | 10 |
| Des Moines | 3,100 | ....do | S.W. | 4,700 | T.S. | 10 |
| Detroit | 2,089 | Unprotected cruiser | S. | 5,227 | T.S. | 10 |
| Dolphin | 1,486 | Dispatch boat | S. | 2,253 | S. | 2 |
| Don Juan de Austria | 1,159 | Gunboat | I. | 1,500 | S. | 4 |
| Dubuque | 1,085 | Gunboat | S.W. | 1,000 | T.S. | 6 |
| Essex | 1,375 | Cruiser | W. | 800 | S. | 6 |
| Florida | 3,214 | Monitor | S. | 2,400 | T.S. | 6 |
| Galveston | 3,200 | Protected cruiser | S.W. | 4,700 | T.S. | 10 |
| Hartford | 2,790 | Cruiser | W. | 2,000 | S. | 13 |
| Helena | 1,392 | Light draft gunb't | S. | 1,988 | T.S. | 8 |
| Isla de Cuba | 1,030 | Gunboat | S. | 2,627 | T.S. | 4 |
| Isla de Luzon | 1,030 | ....do | S. | 2,627 | T.S. | 4 |
| Katahdin | 2,155 | Harbor defence ram | S. | 5,068 | T.S. | *4 |
| Machias | 1,177 | Gunboat | S. | 2,046 | T.S. | 8 |
| Manila | 1,800 | ....do | I. | 750 | S. | 2 |
| Marblehead | 2,089 | Unprotected cruiser | S. | 5,451 | T.S. | 10 |
| Marietta | 1,000 | Composite gunboat | Comp. | 1,054 | T.S. | 6 |
| Mayflower | 2,690 | Cruiser (converted) | S. | 4,700 | T.S. | 2 |
| Miantonomoh | 3,990 | Double-turret monitor | I. | 1,426 | T.S. | 4 |
| Mohican | 1,900 | Cruiser | W. | 1,100 | S. | 6 |
| Montgomery | 2,089 | Unprotected cruiser | S. | 5,580 | T.S. | 10 |
| Nashville | 1,371 | Light-draft gunb't | S. | 2,536 | T.S. | 8 |
| Nevada | 3,214 | Monitor | S. | 2,400 | T.S. | 6 |
| New Orleans | 3,437 | Protected cruiser | S.W. | 7,500 | T.S. | 10 |
| Newport | 1,000 | Composite gunboat | Comp. | 1,008 | S. | 6 |
| Princeton | 1,000 | ....do | Comp. | 800 | S. | 6 |
| Raleigh | 3,213 | Protected cruiser | S. | 10,000 | T.S. | 11 |
| Ranger | 1,020 | Cruiser | I. | 500 | S. | 6 |
| Tacoma | 3,100 | Protected cruiser | S.W. | 4,700 | T.S. | 10 |
| Terror | 3,990 | Double-turret monitor | I. | 1,600 | T.S. | 8 |
| Topeka | 2,372 | Gunboat | I. | 2,000 | T.S. | 6 |
| Vicksburg | 1,000 | Composite gunboat | Comp. | 1,118 | S. | 6 |
| Wheeling | 1,000 | ....do | Comp. | 1,081 | T.S. | 6 |
| Wilmington | 1,392 | Light-draft gunb't | S. | 1,894 | T.S. | 8 |
| Wyoming | 3,214 | Monitor | S. | 2,400 | T.S. | 6 |
| Yorktown | 1,710 | Gunboat | S. | 3,392 | T.S. | 6 |

AUXILIARIES (THIRD RATE.)

| | | | | | | |
|---|---|---|---|---|---|---|
| Abarenda | 4,670 | Collier | S. | 1,050 | S. | *6 |
| Ajax | †7,500 | ....do | S. | 3,000 | S. | .. |
| Alexander | 6,181 | ....do | S. | 1,026 | S. | *1 |
| Arethusa | †6,200 | Tank steamer | S. | ..... | S. | .. |
| Brutus | †6,000 | Collier | S. | 1,200 | S. | *2 |
| Cæsar | 5,016 | ....do | S. | 1,500 | S. | *3 |
| Celtic | 6,428 | Supply ship | S. | 1,890 | S. | .. |
| Culgoa | †6,300 | ....do | S. | †1,500 | S. | *2 |
| Glacier | †7,000 | ....do | S. | 4,000 | S. | .. |
| Hannibal | 4,291 | Collier | S. | 1,100 | S. | *1 |
| Iris | 6,100 | Supply & repair ship | S. | 1,300 | S. | .. |
| Lawton | †4,100 | Transport | S. | 3,200 | S. | .. |
| Leonidas | 4,242 | Collier | S. | 1,000 | S. | .. |
| Marcellus | †4,400 | ....do | I. | 1,200 | S. | *2 |
| Nanshan | †4,827 | ....do | S. | 1,400 | S. | .. |
| Nero | 4,925 | ....do | S. | 1,000 | S. | *4 |
| Relief | †3,000 | Hospital ship | S. | 2,666 | S. | .. |
| Saturn | †6,220 | Collier | I. | 1,500 | S. | *1 |
| Solace | 4,700 | Hospital ship | S. | 3,200 | S. | *3 |
| Sterling | 5,663 | Collier | I. | *926 | S. | *4 |

* Secondary battery. † Estimated.

## FOURTH RATE.

| Name. | Displacement (tons.) | Type. | Hull. | I.H.P. | Propulsion. | Guns (main battery). |
|---|---|---|---|---|---|---|
| Aileen | 192 | Gunboat (conv't'd). | S. | 500 | S. | .. |
| Alvarado | 100 | Gunboat | S. | 137 | S. | *2 |
| Arayat | 200 | ....do | I. | 260 | T.S. | .. |
| Bancroft | 839 | ....do | S. | 1,213 | T.S. | 4 |
| Calamianes | 150 | ....do | I. | 125 | T.S. | .. |
| Callao | 200 | ....do | S. | 250 | T.S. | *9 |
| Dorothea | 594 | Gunboat (conv't'd). | S. | 1,558 | S. | .. |
| Eagle | 434 | ....do | S. | 850 | S. | *4 |
| Elcano | 560 | Gunboat | S. | 600 | T.S. | 4 |
| Elfrida | †173 | Gunboat conv't'd). | S. | 200 | S. | .. |
| Frolic | 607 | ....do | S. | 550 | S. | *6 |
| Gloucester | 786 | ....do | S. | 2,000 | S. | *10 |
| Hawk | 375 | ....do | S. | 1,000 | S. | .. |
| Hist | 472 | ....do | S. | 500 | S. | *9 |
| Hornet | 425 | ....do | S. | 800 | S. | .. |
| Huntress | 82 | ....do | Comp. | ..... | S. | .. |
| Inca | †120 | ....do | W. | 400 | S. | .. |
| Leyte | 150 | Gunboat | I. | 125 | T.S. | .. |
| Mariveles | 142 | ....do | I. | 125 | T.S. | .. |
| Mindoro | 142 | ....do | I. | 125 | T.S. | *3 |
| Oneida | 150 | Gunboat (conv't'd). | W. | 350 | S. | .. |
| Pampanga | 200 | Gunboat | I. | 250 | T.S. | *7 |
| Panay | 142 | ....do | I. | 125 | T.S. | *7 |
| Paragua | 200 | ....do | I. | 250 | T.S. | *8 |
| Peoria | 488 | Gunboat (conv't'd). | S. | ..... | S. | *7 |
| Petrel | 892 | Gunboat | S. | 1,095 | S. | 4 |
| Pinta | 550 | ....do | I. | 310 | S. | .. |
| Quiros | 400 | ....do | Comp. | 208 | S. | *7 |
| Restless | 137 | Gunboat (conv't'd). | I. | 500 | S. | .. |
| Samar | 200 | Gunboat | I. | 250 | T.S. | .. |
| Sandoval | 100 | ....do | S. | 137 | S. | *2 |
| Scorpion | 850 | Gunboat (conv't'd). | S. | 2,800 | T.S. | *10 |
| Shearwater | 122 | ....do | S. | ..... | S. | .. |
| Siren | †315 | ....do | S. | ..... | S. | *1 |
| Stranger | †546 | ....do | I. | 550 | S. | .. |
| Sylph | 152 | ....do | S. | 550 | S. | *1 |
| Sylvia | †302 | ....do | I. | ..... | S. | .. |
| Vesuvius | 929 | Torpedo Practice ship. | S. | 3,795 | T.S. | *3 |
| Villalobos | 400 | Gunboat | Comp. | 208 | S. | *8 |
| Vixen | 806 | Gunboat (conv't'd). | S. | 1,250 | S. | *10 |
| Wasp | 630 | ....do | S. | 1,800 | S. | .. |
| Wolverine | 685 | Cruiser | I. | 365 | P. | *10 |
| Yankton | 975 | ....do | S. | 750 | S. | *4 |

## AUXILIARIES (FOURTH RATE).

| | | | | | | |
|---|---|---|---|---|---|---|
| General Alava | 1,400 | Transport | S. | 770 | S. | *4 |
| Justin | † 3,300 | Collier | S. | ..... | S. | .. |
| Lebanon | 3,375 | ....do | I. | ..... | S. | *4 |
| Pompey | †3,085 | ....do | S. | ..... | S. | *2 |
| Zafiro | †2,000 | Transport | S. | 850 | S. | *2 |

* Secondary battery. † Estimated.

## TORPEDO VESSELS.

| Name. | Displacement (tons). | Type. | Hull. | I.H.P. | Propulsion. | Guns (main battery). |
|---|---|---|---|---|---|---|
| Bainbridge | 420 | Torpedo boat des | S. | 8,000 | T.S. | *2 |
| Barry | 420 | ....do | S. | 8,000 | T.S. | *2 |
| Chauncey | 420 | ....do | S. | 8,000 | T.S. | *2 |
| Dale | 420 | ....do | S. | 8,000 | T.S. | *2 |
| Decatur | 420 | ....do | S. | 8,000 | T.S. | *2 |
| Hopkins | 408 | ....do | S. | 7,200 | T.S. | *2 |
| Hull | 408 | ....do | S. | 7,200 | T.S. | *2 |
| Lawrence | 400 | ....do | S. | 8,400 | T.S. | *2 |
| Macdonough | 400 | ....do | S. | 8,400 | T.S. | *2 |
| Paul Jones | 420 | ....do | S. | 7,000 | T.S. | *2 |
| Perry | 420 | ....do | S. | 7,000 | T.S. | *2 |
| Preble | 420 | ....do | S. | 7,000 | T.S. | *2 |
| Stewart | 420 | ....do | S. | 7,000 | T.S. | *2 |
| Truxtun | 433 | ....do | S. | 8,300 | T.S. | *2 |
| Whipple | 433 | ....do | S. | 8,300 | T.S. | *2 |
| Worden | 433 | ....do | S. | 8,300 | T.S. | *2 |
| Bagley | 167 | Torpedo boat | S. | 4,200 | T.S. | *3 |
| Bailey | 235 | ....do | S. | 5,600 | T.S. | *2 |
| Barney | 167 | ....do | S. | 4,200 | T.S. | *3 |
| Biddle | 167 | ....do | S. | 4,200 | T.S. | *3 |
| Blakely | 165 | ....do | S. | 3,000 | T.S. | *3 |
| Cushing | 105 | ....do | S. | 1,720 | T.S. | *3 |
| Dahlgren | 146 | ....do | S. | 4,200 | T.S. | *2 |
| Davis | 132 | ....do | S. | 1,750 | T.S. | *3 |
| De Long | 165 | ....do | S. | 3,000 | T.S. | *3 |
| Dupont | 165 | ....do | S. | 3,400 | T.S. | *3 |
| Ericsson | 120 | ....do | S. | 1,800 | T.S. | *2 |
| Farragut | 273 | ....do | S. | 5,600 | T.S. | *2 |
| Foote | 142 | ....do | S. | 2,000 | T.S. | *3 |
| Fox | 132 | ....do | S. | 1,750 | T.S. | *3 |
| Gwin | 46 | ....do | S. | 850 | S. | *2 |
| McKee | 65 | ....do | S. | 850 | S. | *2 |
| Mackenzie | 65 | ....do | S. | 850 | S. | *2 |
| Manley | 30 | ....do | S. | 250 | S. | *1 |
| Morris | 105 | ....do | S. | 1,750 | T.S. | *3 |
| Nicholson | 218 | ....do | S. | 3,000 | T.S. | *3 |
| O'Brien | 213 | ....do | S. | 3,500 | T.S. | *3 |
| Porter | 165 | ....do | S. | 3,400 | T.S. | *3 |
| Rodgers | 142 | ....do | S. | 2,000 | T.S. | *3 |
| Rowan | 182 | ....do | S. | 3,200 | T.S. | *3 |
| Shubrick | 166 | ....do | S. | 3,000 | T.S. | *3 |
| Somers | 145 | ....do | S. | 1,900 | T.S. | *2 |
| Stiletto | 31 | ....do | W. | 359 | S. | *2 |
| Stockton | 166 | ....do | S. | 3,000 | T.S. | *3 |
| Stringham | 340 | ....do | S. | 7,200 | T.S. | *2 |
| Talbot | 46½ | ....do | S. | 850 | S. | *2 |
| T.A.M.Craven | 146 | ....do | S. | 4,200 | T.S. | *2 |
| Thornton | 165 | ....do | S. | 3,000 | T.S. | *3 |
| Tingey | 165 | ....do | S. | 3,000 | T.S. | *3 |
| Wilkes | 165 | ....do | S. | 3,000 | T.S. | *3 |
| Winslow | 142 | ....do | S. | 2,000 | T.S. | *3 |
| Adder | 120 | Submarine tor.boat | S. | 160 | S. | *1 |
| Grampus | 120 | ....do | S. | 160 | S. | *1 |
| Holland | 73 | ....do | S. | 150 | S. | *1 |
| Moccasin | 120 | ....do | S. | 160 | S. | *1 |
| Pike | 120 | ....do | S. | 160 | S. | *1 |
| Plunger | 120 | ....do | S. | 160 | S. | *1 |
| Porpoise | 120 | ....do | S. | 160 | S. | *1 |
| Shark | 120 | ....do | S. | 160 | S. | *1 |

* Torpedo tubes.

UNDER CONSTRUCTION.

| Name. | Displacement (tons). | Type. | Hull. | I.H.P. | Propulsion. | Guns (main battery). | Place where building. |
|---|---|---|---|---|---|---|---|
| Connecticut | 16,000 | 1st class battleship | S. | 16,500 | T.S. | 24 | Navy Yard, New York. |
| Kansas | 16,000 | do. | S. | 16,500 | T.S. | 24 | New York Ship Building Co., Camden, N. J. |
| Louisiana | 16,000 | do. | S. | 16,500 | T.S. | 24 | Newport News Ship Building and Dry Dock Co., N'p't News, Va. |
| Minnesota | 16,000 | do. | S. | 16,500 | T. S. | 24 | Do. |
| Vermont | 16,000 | do. | S. | 16,500 | T. S. | 24 | Fore River S. & E. Co., Quincy, Mass. |
| Michigan | .. | do. | .. | .. | .. | .. | Not yet building or contracted for. |
| South Carolina | .. | do. | .. | .. | .. | .. | Do. |
| New Hampshire | 16,000 | do. | S. | 16,500 | T. S. | 24 | New York Ship Building Co., Camden, N. J. |
| Georgia | 14,948 | do. | S. | 19,000 | T. S. | 24 | Bath Iron Works, Bath, Me. |
| Nebraska | 14,948 | do. | S. | 19,000 | T. S. | 24 | Moran Bros. Co., Seattle, Wash. |
| New Jersey | 14,948 | do. | S. | 19,000 | T. S. | 24 | Fore River S. & E. Co., Quincy, Mass. |
| Rhode Island | 14,948 | do. | S. | 19,000 | T. S. | 24 | Do. |
| Virginia | 14,948 | do. | S. | 19,000 | T. S. | 24 | Newport News Ship Building and Dry Dock Co., N'p't News, Va. |
| Idaho | 13,000 | do. | S. | 10,000 | T. S. | 20 | Wm. Cramp & Sons, Philadelphia, Pa. |
| Mississippi | 13,000 | do. | S. | 10,000 | T. S. | 20 | Do. |
| Tennessee | 14,500 | Armored cruiser. | S. | 23,000 | T. S. | 20 | Do. |
| Washington | 14,500 | do. | S. | 23,000 | T. S. | 20 | New York Ship Building Co., Camden, N. J. |
| California | 13,680 | do. | S. | 23,000 | T. S. | 18 | Union Iron Works, San Francisco, Cal. |
| North Carolina | 14,500 | do. | S. | 23,000 | T. S. | 20 | Newport News Ship Building and Dry Dock Co., N'p't News, Va. |
| Montana | 14,500 | do. | S. | 23,000 | T. S. | 20 | Do. |
| South Dakota | 13,680 | do. | S. | 23,000 | T. S. | 18 | Union Iron Works, San Francisco, Cal. |
| Charleston | 9,700 | Protected cruiser. | S. | 21,000 | T. S. | 14 | Newport News Ship Building and Dry Dock Co., N'p't News, Va. |
| Milwaukee | 9,700 | do. | S. | 21,000 | T. S. | 14 | Union Iron Works, San Francisco, Cal. |
| St. Louis | 9,700 | do. | S. | 21,000 | T. S. | 14 | Neafie & Levy, Philadelphia, Pa. |
| Chester | 3,750 | Scout cruiser | S. | 16,000 | .. | 12 | Bath Iron Works, Bath, Me. |
| Birmingham | 3.750 | do. | S. | 16,000 | .. | 12 | Fore River Ship and Engine Co., Quincy, Mass. |
| Salem | 3,750 | do. | S. | 16,000 | .. | 12 | Do. |
| Paducah | 1,085 | Gunboat | S.W. | 1,000 | T. S. | 6 | Gas Engine and Power Co., and Chas. L. Seabury & Co., consolidated, Morris Heights, N.Y. |
| Erie | 12,500 | Fleet collier. | S. | 7,500 | T. S. | 4 | To be built at Navy Yard, New York. |
| Ontario | 12,500 | do. | S. | 7,500 | T. S. | 4 | To be built at Navy Yard, Mare Island. |
| Gunboat No. 16 | .. | Gunboat | S. | .. | T. S. | .. | Contract not yet awarded. |
| Cumberland | 1,800 | Training ship | S. | .. | .. | 6 | Navy Yard, Boston, Mass. |
| Intrepid | 1,800 | do. | S. | .. | .. | 6 | Navy Yard, Mare Island, Cal. |
| Goldsborough (No. 20) | 255 | Torpedo boat | S. | 6,000 | T. S. | *2 | Navy Yard, Puget Sound. |
| Steam Tug No. 10 | .. | Seagoing tug | S. | .. | .. | .. | Not yet building or contracted for. |
| Steam Tug No. 11 | .. | do. | S. | .. | .. | .. | Do. |
| Submarine 9 | 273 | Submarine | S. | .. | T. S. | *2 | Fore River Ship and Engine Co., Quincy, Mass. |
| Submarine 10 | 170 | do. | S. | .. | T. S. | *2 | Do. |
| Submarine 11 | 170 | do. | S. | .. | T. S. | *2 | Do. |
| Submarine 12 | 170 | do. | S. | .. | T. S. | *2 | Do. |

*Torpedo tubes.

## SUMMARY OF VESSELS IN THE UNITED STATES NAVY.

VESSELS FIT FOR SERVICE, INCLUDING THOSE UNDER REPAIR.

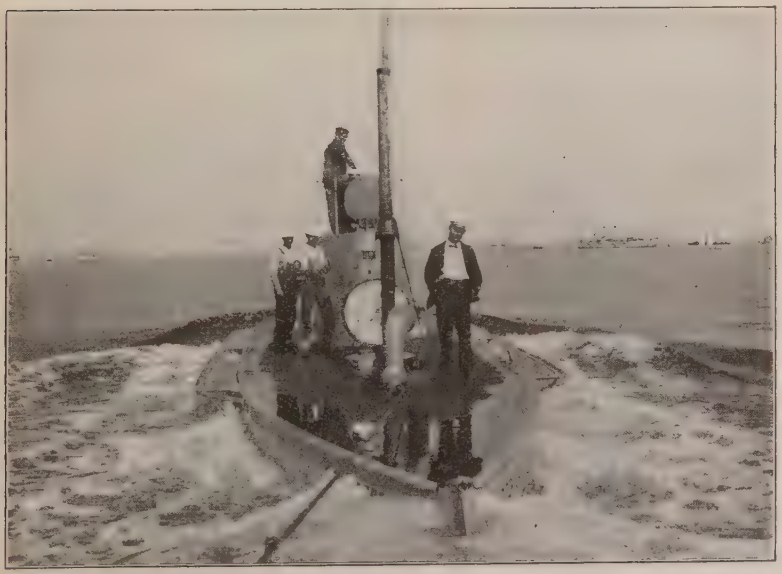
| | |
|---|---|
| First-class battleships | 12 |
| Second-class battleship | 1 |
| Armored cruisers | 6 |
| Armored ram | 1 |
| Single-turret harbor-defense monitors | 4 |
| Double-turret monitors | 6 |
| Protected cruisers | 19 |
| Unprotected cruisers | 3 |
| Gunboats | 12 |
| Light-draft gunboats | 3 |
| Composite gunboats | 6 |
| Training ship (Naval Academy), sheathed | 1 |
| Special class (Dolphin-Vesuvius) | 2 |
| Gunboats under 500 tons | 18 |
| Torpedo-boat destroyers | 16 |
| Steel torpedo boats | 33 |
| Submarine torpedo boats | 8 |
| Wooden torpedo boat | 1 |
| Iron cruising vessels, steam | 6 |
| Wooden cruising vessels, steam | 6 |
| Wooden sailing vessels | 8 |
| Tugs | 41 |
| Auxiliary cruisers | 5 |
| Converted yachts | 23 |
| Colliers | 16 |
| Supply ships and hospital ships | 14 |
| Total | 271 |

VESSELS UNDER CONSTRUCTION OR AUTHORIZED.

| | |
|---|---|
| First-class battleships | 15 |
| Armored cruisers | 6 |
| Protected cruisers | 3 |
| Scout cruisers | 3 |
| Gunboat for great Lakes (not begun) | 1 |
| Composite gunboats | 2 |
| Steel torpedo boats | 2 |
| Submarine torpedo boats | 4 |
| Training ships | 2 |
| Training brig | 1 |
| Colliers | 2 |
| Tugs | 2 |
| Total | 43 |

VESSELS UNFIT FOR SEA SERVICE.

| | |
|---|---|
| Wooden cruising vessels, steam | 10 |
| Wooden sailing vessels | 5 |
| Total | 15 |
| Grand Total | 329 |



THE "LAKE" SUBMARINE BOAT ON THE SURFACE.

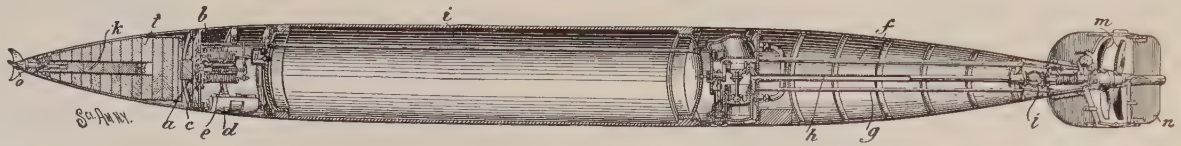
## SUBMARINE BOATS.

### NUMBER AND DESCRIPTION OF EACH TYPE.

| Type. | No. | Tons. | Length | Motive Power. | | Ext. Speed. | Remarks. | No. of Torp. Tubes. |
|---|---|---|---|---|---|---|---|---|
| | | | | Afloat. | Under Wtr. | | | |
| BRITAIN, 29. | | | ft. | | | | | |
| Holland, No. 1. | 1 | 75 | 63 | Gasoline | Electricity | 8 | ..... | 1 |
| Holland, Nos. 2 and 5. | 4 | 120 | 100 | " | " | 9–10 | ..... | 1 |
| A. 1–4. | 4 | 200 | 125? | " | " | 10–12 | High conning tower. A1, accidentally sunk, Mar. 1904, raised and repaired. | 1 |
| A. 5–13. | 9 | 250 | 150 | " | " | 14? | Improved boats of greater sea-going capacity. | 2 |
| A. 14. | 1 | 300? | .... | " | " | ? | Experimental boat. | ? |
| 10 new boats. | Details unknown. To be laid down 1904–5. | | | | | | | |
| FRANCE, 58. | | | | | | | | |
| Gymnote. | 1 | 30 | 59 | Electricity | | 8 | Experimental. Launched 1889. | 0 |
| Gustave Zédé. | 1 | 266 | 159 | Electricity | | 8 | Can descend to 65 ft. | 1 |
| Morse. | 1 | 144 | 118 | Electricity | | 12 | One of the most successful submarines. Cost £25,920. | 1 |
| Narval. | 1 | 200 | 111½ | Steam | Electricity | 11 | So called "submersible." Takes 20 minutes to plunge. Can fire torpedoes in all directions. | .... |
| Silure. | 4 | 106 | 111½ | Steam | Electricity | 12 | Submersibles. | ..... |
| Algérien. | 2 | 146 | 118 | Electricity | | 9 | Morse type. | 1 |
| Farfadet. | 4 | 185 | 135½ | Electricity | | 12 | Improved Morses. | 1 |
| Alose. | 20 | 68 | 77 | Electricity | | 8 | Improved Gymnotes. Will have surface motors, with accumulators for submerged work. | ? |
| Q. 35. | 1 | 168 | 122 | Gasoline | Electricity | 10½ | Twin screws. | 4 |
| Q. 36. | 1 | 262 | 135 | Heavy oil | Electricity | 11 | Single screw. | 4 |
| Q. 37. | 1 | 213 | 142 | Petrol | | 11 | ..... | 2 |
| Q. 38–9. | 2 | 172 | 117 | Steam | Electricity | 10 | ..... | 4 |
| Omega. | 1 | 300 | 160 | Heavy oil | Electricity | 11 | ..... | 4 |
| Q. 41–46. | 6 | 400 | .... | Details unknown | | ..... | ..... | ? |
| Q 47. | Exper. boat. | | | ..... | ..... | ..... | ..... | ? |
| Q. 48–58. | Projected | | | | | | | |
| GERMANY, 8. | | | | | | | | |
| U. 1–2. | 2 | 200 | 114 | Steam | ..... | 11 | Old-fashioned Nordenfelt type. | |
| U. 5. | 1 | 180 | 101 | " | ..... | ..... | | |
| No. 1. | 1 | 120 | 63 | Gasoline | Electricity | 8 | Holland type. | 1 |
| No. 2. | 1 | 200 | 110 | " | " | 10 | Improved Holland. | 2 |
| No. 3. | 1 | 40? | 50 | Electricity | | 6 | Holland, to be carried on shipboard. | 1 |
| Nos. 4–5. | 2 small submersibles. | | | | | ..... | | |
| U. STATES, 13. | | | | | | | | |
| Holland. | 1 | 74 | 54 | Gasoline | | 8 | Small experimental. | 1 |
| Adder. | 7 | 120 | 63¾ | Gasoline | | 8 | Similar to British Hollands. | 1 |
| Experimental. | 5 | .... | Details uncertain | | | | | |
| RUSSIA, 12. | | | | | | | | |
| Peter Kochka. | 1 | 20 | 50 | Electricity | | 8 | Cigar-shaped sectional submarine boat. | ? |
| New type. | 11 | .... | 66 | Gasoline | Electricity | ? | To carry crew of 12. Cigar-shaped. | |
| ITALY, 10. | | | | | | | | |
| Delfino. | 1 | 107 | 79 | Electricity | | 8½ | Experimental. | 2 |
| Tritone. | 1 | .... | 56 | | | | | |
| Glauco. | 2 | .... | 55 | ? | | 14 | Submersible. To have a range of 2,000 knots. | |
| New boat. | 6 | .... | .... | ..... | | ..... | Reported to be an improved Glauco. | |
| SPAIN, 1. | | | | | | | | |
| Peral. | 1 | 87 | 72 | Electricity | | 10 | A failure. | |

The details are only approximate. Much secrecy is observed by all the Powers, especially as to design, speed, etc —"*Daily Mail*" *Year Book.*

SECTIONAL DIAGRAM SHOWING THE INTERIOR OF A JAPANESE TORPEDO BOAT DESTROYER.




*t*, explosive charge; *k*, cartridge primer; *o*, safety device to check premature explosion; *a*, depth-regulating piston; *e*, rod of swinging pendulum *d*; *i*, compressed air chamber; *f* and *g*, tubes that contain rods connecting depth-regulating device *a*, *e*, *d*, with diving rudders; *l*, bevel gear for causing propellers *m* to rotate in opposite directions; *n*, vertical rudder.

LONGITUDINAL SECTION THROUGH A SCHWARTZKOPFF TORPEDO, A TYPE USED IN THE RUSSIAN NAVY.

## THE TORPEDO BOAT IN MODERN WARFARE.

The Russo-Japanese war has proved the wisdom of building torpedo boat destroyers of the dimensions and power that characterize the latest models. With their length of 220 feet, beam of over 20 feet and draft of between 9 and 10 feet, giving a displacement of between 300 and 400 tons, the modern destroyer is a very serviceable sea boat, which was more than could be said for the torpedo boat of an earlier decade. The high freeboard and the provision of a raised turtle-back forward, render these boats able to maintain their high speed in fairly rough water, and in the present operations the flotillas of Japanese destroyers seem to have been perfectly well able to keep the sea in all weather. Evidently the lessons taught by the disasters that happened to some of the high-powered British torpedo boat destroyers, when they were badly wrenched, and in one case actually broken in two in a heavy seaway, have been laid to heart, and the Japanese destroyers which did such good work around Port Arthur are evidently seaworthy vessels.

A surprising feature of torpedo boat service in the Far Eastern struggle is the wide range of duties which were assigned to the destroyers. Scouting work which ordinarily would be given to cruisers from 3,000 to 6,000 tons displacement was satisfactorily carried out by these little 400-ton craft.

By reference to the section diagram on page 77 the reader can obtain a very complete idea of a torpedo boat interior. Forward in the bow is a collision compartment formed by a bulkhead located several feet from the bow. Aft of that is the chain locker, and then the torpedoes, of which half a dozen are carried on a vessel of this character. Since the torpedo boat carries no armor whatever, the torpedoes, the war-heads, and the magazines are placed below the water-line, where they are safe from any except a plunging shot. The torpedoes are stowed with their war-heads containing the guncotton charge unscrewed, the latter being stowed separately, as shown in the engraving. Aft of the war-heads is the forward magazine and a compartment given up to the general ship's stores. On the deck above are the quarters for the crew, which will number between fifty and sixty men in the larger boats.

## THE MODERN TORPEDO.

Commenting during the late Spanish war upon the efficiency of the torpedo, we said: "Although torpedo warfare has not yet achieved results at all proportionate to the amount of thought and skill that have been devoted to it, the failure has probably been due more to a lack of opportunity or of efficient handling than to any deficiency in the torpedo itself." The startling events that marked the opening of the Russo-Japan war have established the truth of that statement, for in the hands of an alert, intelligent and daring people, this deadly weapon, in the first half hour of hostilities, so badly crippled two of the finest battleships and one of the best cruisers of the Russian navy that they had to be beached, and a blow was struck at the naval prestige of Russia from which that country will take many years to recover. At the same time, the Port Arthur torpedo attack must be judged at its true value; and, therefore, we must not lose sight of the fact that information is finding its way to the public ear which makes it pretty evident that the Russian ships were not looking for, and were totally unprepared to receive, a torpedo attack. If this is the case, what has been proved is that if the torpedo boat can get unmolested within easy range, the torpedo is fairly sure of its mark—and this we all knew well enough before the war began.

The Whitehead torpedo is undergoing constant development, the latest improvement being the introduction of the gyroscope for the purpose of keeping the torpedo more accurately upon its true course. The latest patterns include this device and are generally of larger diameter and greater length than the earlier types.

We show on the preceding page an illustration of a Schwartzkopff torpedo, which is the type used in the Russian navy. It is merely a modification of the Whitehead and operates upon the same principles.

The torpedo here shown consists of a cigar-shaped body of phosphor-bronze or steel, divided into six separate compartments as follows: (1) The magazine, (2) the secret chamber, (3) the reservoir, (4) the engine compartment, (5) the buoyancy compartment, (6) the bevel-gear chamber.

The magazine contains the explosive charge, which consists of a series of disks of wet guncotton packed snugly together. The cartridge primer, *k*, for exploding the charge, consists of several cylinders of dry guncotton packed in a tube which passes through perforations in the guncotton disks, *t*. The foremost of the six cylinders contains a detonating primer consisting of fulminate of mercury. The small propeller at the extreme point of the torpedo is part of an ingenious safety device for preventing premature explosion in handling. When not in use, the firing pin is held in check by a sleeve; but as soon as the torpedo strikes the water the rotation of the little propellers releases the sleeve and leaves the firing pin ready to strike the detonating primer the moment the torpedo meets an obstruction.

The "secret chamber" is the most ingenious part of this most ingenious piece of mechanism. Its piston, pendulum and springs perform the important work of regulating the horizontal rudders which keep the torpedo at the proper depth. Immediately in front of the secret chamber is a narrow compartment perforated on its walls to allow the outside water to enter. The front wall of the secret chamber carries a piston, *a*, which can move in the direction of the axis of the torpedo. The pressure of the water is resisted by three coiled springs, as shown in the longitudinal section. At a certain predetermined depth, according to the tension on the springs, the springs and water pressure will be in equilibrium; below that depth the piston will be driven in by the water pressure, and above it the springs will push forward the piston. To prevent too sudden oscillation in this action, the piston is connected to the rod, *e*, of a swinging pendulum, *d*. The motion of the piston is communicated by rods, which pass through the hollow stay rods of the air chamber to the horizontal or diving rudders. If the torpedo goes too deep the piston moves back, the pendulum swings forward and the rudders are elevated, the reverse movements taking place if the immersion is not sufficient. When a torpedo dives into the water, the first part of its run is made on a wave line which crosses and recrosses the desired and ultimate level of immersion, the piston and the pendulum gradually bringing the torpedo to a true course. The reservoir forms the central body of the "fish." It is made of forged cast steel and is tested up to seventy atmospheres. A tuyere at its after end feeds the air to the engine. The torpedo is driven by a three-cylinder engine, with cylinders 120 deg. apart, acting on a common crank. The engine is started by means of a valve which is opened by a lever striking a projecting lug on the launching tube, when the torpedo is fired.

The buoyancy chamber is an air-tight compartment, the purpose of which is to afford the proper buoyancy to the torpedo; it carries a piece of lead ballast, by shifting which the trim can be controlled. The two tubes, *f* and *g*, carry the connecting rods for controlling the horizontal diving rudders.

Next comes the bevel-gear chamber, where is located the gear, *l*, for causing the propellers, *m*, to rotate in opposite directions. The after propeller is keyed to the main shaft; the forward propeller is keyed to a sleeve which rotates freely upon the main shaft, and the motion is reversed by means of two bevel-wheel gears which turn on a spindle at right angles to the main shaft. The "tail" consists of a stock with vertical vanes, which act as the vertical rudder, and two frames which carry the horizontal rudders.

The torpedo is fired from a launching tube by the explosion of a small charge of gunpowder behind it. This compresses the air which surrounds the rear half of the torpedo and thrusts it out of the tube without any serious jar.

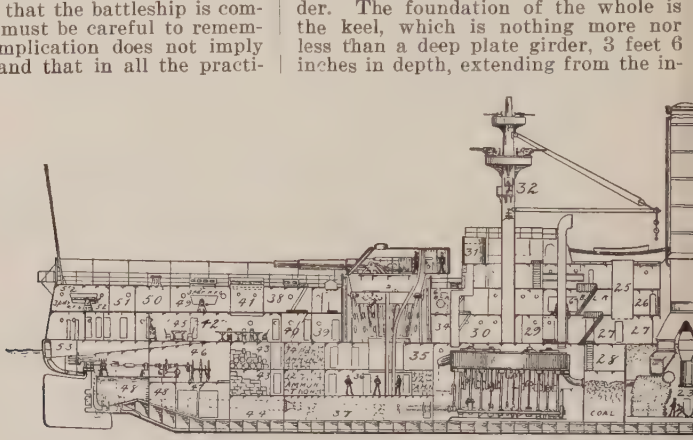
The range and speed of the torpedoes vary with the size. The weapon here shown is 14 inches in diameter, 15 feet in length, carries 90 pounds of guncotton and has a speed of 28 knots for a range of 800 yards. The 18-inch Whitehead torpedo is 16 feet 7½ inches in length, carries a charge of 220 pounds of guncotton and has a speed of 31 knots for 1,000 yards.

## INTERIOR OF A BATTLESHIP.

The story of the complicated character of the interior of a modern battleship is one that has grown somewhat stale in the telling, and it is not the fault of the magazine writer and the occasional correspondent of Sunday supplements, if the general public is not satisfied that a great battleship or cruiser is complicated beyond the power of words to express.

In saying that the battleship is complicated we must be careful to remember that complication does not imply confusion; and that in all the practicable achievements of engineering, it would be difficult, if not impossible, to find a structure which, in spite of the many parts of which it is made up and the enormous elaboration of detail that it manifests, is really so harmoniously proportioned, or is better fitted to the ends for which it was designed. There are some subjects of which an illustration will tell more in five minutes than tongue or pen can explain in an hour; and in presenting the accompanying view of the interior of one of the latest battleships of the United States Navy, we shall not attempt to give any elaborate description of the vessel, but will leave it to the diagram to tell its own story.

The drawing is what is known as an inboard profile; that is to say, it is a vertical, central, longitudinal section through the whole length of the ship. The huge structure of which we thus obtain an interior view, is a little under 450 feet in length from the extreme tip of the ram to the end of the rudder. The foundation of the whole is the keel, which is nothing more nor less than a deep plate girder, 3 feet 6 inches in depth, extending from the inboard end of the ram structure to the rudder post. Bisecting it at every 3 feet of its length occurs one of the plate girder frames or ribs, which extend athwartship, and run up to the under edge of the armor shelf, where they are reduced to a depth of say from 18 to 12 inches, the frames extending up the sides of the ship to the level of the upper deck. On the outside of these frames is riveted the outer plating of the ship, and upon the inside of the frames, extending as high up as the under side of the water-line belt, say 4 or 5 feet below the water-line, is riveted an inner shell of plat-



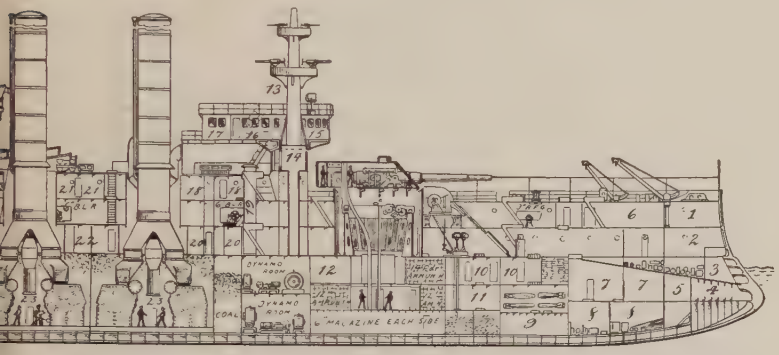

SECTION

1. Crew's showers.
2. Paints and oils.
3. Cofferdam.
4. Trimming tank.
5. Trimming tank.
6. Seamen's lavatory.
7. Bread and dry provisions.
8. Construction stores.
9. Torpedoes and submarine mines.
10. Stores.
11. Hold and cable. Tier each side.
12. Blower room.
13. Military mast.
14. Conning tower.
15. Pilot house.
16. Chart room.
17. Officers' room.
18. Crew's galley.
19. Trunk to dynamos.
20. Wash rooms.
21. Officers' galley.
22. Firemen's room.
23. Boiler room.
24. Firemen's wash room.
25. Trunk to evaporating room.
26. Armory.
27. Evaporator room.

ing. The space between the outer and inner plating is divided up by the frames into transverse water-tight chambers 3 feet in width, and every one of these spaces is subdivided by seven or eight longitudinal plate girders which are built into the double bottom, as it is called, parallel with the keel and extending, most of them, the entire length from stem to stern. Consequently it will be seen that the space between the outer and inner shells of the ship's bottom is divided into an innumerable number of separate compartments, measuring 3 feet in depth by 4 feet in length by about

entrance of the fragments of heavy, high-explosive shells, bursting within the ship above the water-line, a steel deck, 2 to 3 inches in thickness, known as the protective deck, extends at about the level of the water-line over the whole of the vitals, and is continued in a gently curving slope to the ram forward and to the stem aft. In the vessel here shown this steel deck is 1½ inches thick on the flat and 3 inches thick on the slopes.

Now, the space below the protective deck is divided up by a large number of transverse, water-tight bulkheads of steel plating, there being nineteen



ODERN BATTLESHIP.

28. General workshop.
29. Warrant officers' pantry.
30. Warrant officers' dining room.
31. Signal tower.
32. Military mast.
33. Crane.
34. Junior officers' stateroom.
35. Blower room.
36. 12-inch handling room.
37. Shaft alley and 6-inch magazines.
38. Admiral's office.
39. Junior officers' pantry.
40. Wardr m pantry.
41. Skylight trunk to wardroom.
42. Dining room.
43. Stores.
44. Bread and dry provisions.
45. Ward room.
46. Steering machinery room.
47. Fresh water.
48. Trimming tank.
49. Admiral's cabin.
50. Admiral's stateroom.
51. Admiral's lavatory.
52. Admiral's after-cabin.
53. Cofferdam.

6 feet in width. The plates are securely riveted together.

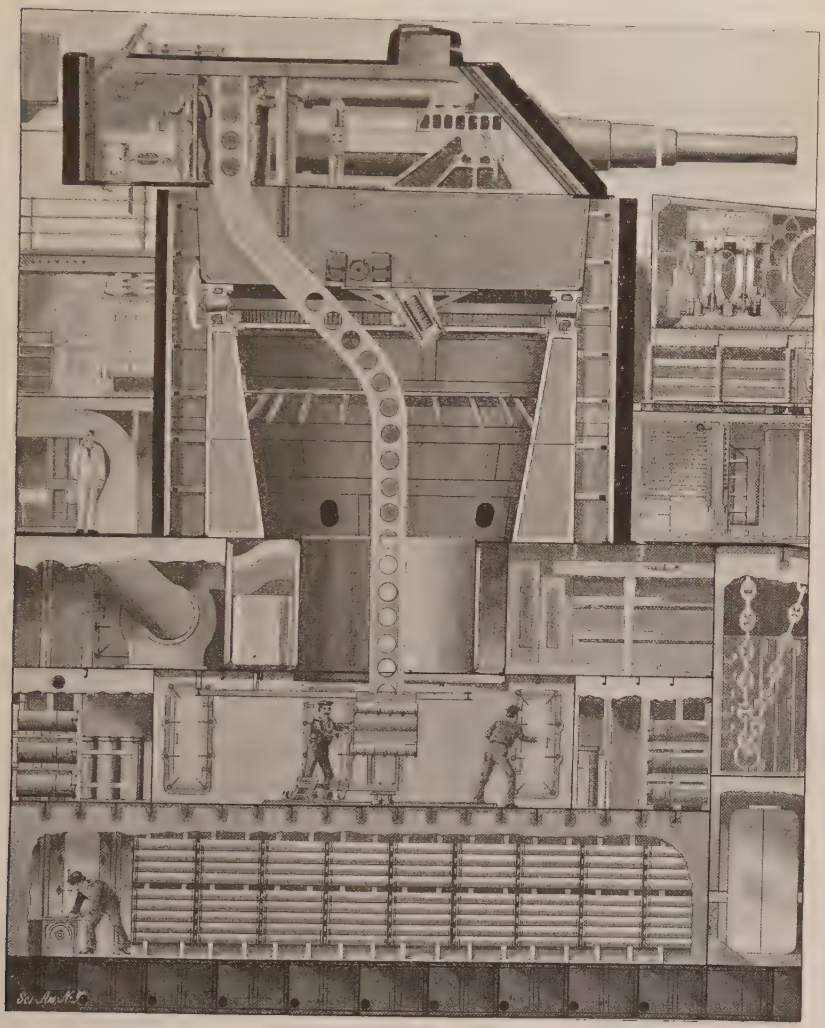
Above the inner floor or platform the central portion of the vessel is taken up by the magazines, boiler rooms and engine rooms. These because of their vast importance, are known as the ship's vitals, and great care is taken to provide them against the entrance of heavy projectiles of the enemy, and, as far as may be, against the attack of the still more deadly torpedo. The engines and boilers are so proportioned as to height that they do not extend above the water-line; and to protect them from plunging shot, or from the

of these bulkheads altogether. They extend from the inner shell of the vessel to the under side of the protective deck. They are riveted perfectly water-tight, communication from compartment to compartment being by water-tight doors. Forward in the bow are the trimming tanks, used to assist in bringing the vessel to an even keel. Then abaft of the collision bulkhead are bread and dry provision stores, and the construction stores. In the next compartment, which is divided into three decks, we have on the floor of the ship a storeroom for torpedo gear, submarine mines, etc. Above this is

the under-water torpedo room, and immediately below the protective deck are kept the paymaster's stores and life preservers. In the next compartment, below on the platform, are the anchor gear and chain lockers, and above this the navigator's stores. Passing through the next bulkhead we come to the vitals of the ship proper, with the 6-inch gun magazines on the floor, the 12-inch magazines and handling rooms on the deck above, and above this the 14-pounder ammunition and blower rooms. Above the magazines, and resting on the protective deck, is the barbette of the forward pair of 12-inch guns, the armor and its relative thickness being shown by heavy, black lines; while in front of the barbette the heavy sloping black line indicates the athwartship sloping bulkhead, placed there to prevent raking projectiles from passing through the entire structure of the ship. Immediately to the rear of the forward barbette is seen the coning tower, with the heavily armored tube which protects the telephones, electric wires, fuse tubes, etc., that pass from the tower down below the protective deck. In the next compartment, aft of the magazines, are the dynamo rooms; and then between the next two bulkheads is placed an athwartship coal bunker. A similar athwartship coal bunker extends athwartship on the other side of the boiler rooms; and it must be understood that at the side of the boiler rooms are the wing bunkers which run aft for the whole length of the boiler rooms and engine rooms. The boiler installation on this particular ship is entirely of the water-tube type, and it consists of twenty-four units arranged in six separate water-tight compartments, three on each side of the center line of the vessel. Aft of the boiler rooms comes the athwartship coal bunker above referred to, and then in two separate water-tight compartments are the twin-screw engines. Aft of the engines in another compartment is contained a complete set of magazines similar to that beneath the forward barbette, and above them, resting on the protective deck is the after barbette and turret, with its pair of 12-inch guns. Aft of the magazines come more compartments, devoted to stores. In the next compartment down on the platform, are the fresh-water tanks and two trimming tanks, and on the deck above, below the protective deck are, first, the steering-machinery room, and then the steering-gear room, each being in a separate water-tight compartment. This completes the description of the space below the protective deck.

The protective deck is known more generally among seamen as the berth deck. Above that, at a distance of about 8½ feet, comes the main deck, and 8½ feet above that the upper deck, while amidships, between the two main turrets, is the superstructure, the deck of which is known as the superstructure or boat deck. The berth deck and main deck are devoted to the living accommodations of the officers and crew, the crew being amidships and forward, and the officers aft. The berth deck, as its name would indicate, is largely devoted to the berthing and general living accommodation of the crew. Here are also to be found, in the wake of the forward gun turrets, on one side the sick bay, and on the other side the refrigerating room and ice machine. Aft of that, on the port side, are the sick bay, lavatory, dispensary, machinists' quarters, ordnance workshop and blowers; while on the starboard side are the petty officers' quarters, the laundry, and the drying-room. Then, in the wake of the boiler-rooms, on each side of the ship, are coal bunkers which add their protection to that of the side armor of the vessel. In the center of the ship are washrooms for the crew and firemen. Aft of the coal bunkers on this deck come the officers' quarters. On both sides of the ship are the staterooms of the junior officers, and the wardroom staterooms, while between them is a large wardroom and dining-room with its pantry. The extreme aft portion of the berth deck is taken up by officers' lavatories, etc.

On the main deck above, forward, is more berthing accommodation for the crew, also shower baths and lavatories, while amidships are found the various galleys for the crew and the officers, arranged between the basco of the smokestacks, while amidships in the wings of the vessel is more berthing space for the crew. Aft on the main deck the space is given up largely to accommodations for the senior officers and for the admiral, which, by the way, give one an impression more of commodiousness than of rich or extravagant furnishing. Forward, above the conning tower, are the pilothouse, chartroom and the room of the commanding officer. In the particular ship shown, the heavier guns are mounted on the upper deck, two 12-



LONGITUDINAL SECTION THROUGH A UNITED STATES BATTLESHIP SHOWING 12-INCH GUN TURRET, BARBETTE, HANDLING ROOM, AND MAGAZINES.

inch guns in a turret forward and two aft, and eight 8-inch guns in two armored turrets, two on each broadside amidships. The intermediate battery of twelve 6-inch guns is mounted on the main deck, the guns firing through casemates. On this deck are also eight 3-inch guns, four forward and four aft; there are also four 3-inch guns, mounted in broadside on the upper deck, within the superstructure. The new method of emplacing guns on our warships, by which it is possible to swing the guns around until their muzzles are flush with the side of the ship, has the good effect of leaving the side of the ship free from projecting objects when the vessel is in harbor, and of leaving the living spaces of the crew but very slightly obstructed.

## SECTION THROUGH THE TURRET AND BARBETTE OF A MODERN BATTLESHIP.

In the foregoing illustration, showing the interior of a turret and barbette on a modern American battle ship, the section has been carried down through the structure of the ship to the keel. It is taken on a vertical plane in the line of the keel and includes enough of the ship in the fore and aft direction to take in the ammunition and handling rooms, and show the methods of storing the shot and shell and powder and the means for bringing it up to the breech of the gun. Commencing at the bottom of the section we have, first, the outside plating of the ship; then about four feet above that is the inside plating, or inner bottom, as it is called. This space is divided laterally by the frames of the ship, which run across the bottom and up the sides to the shelf, upon which the side armor rests. Upon the double bottom, and between that and the first deck above, is a magazine where the ammunition is stored in racks as shown in the illustration, this particular ammunition being for the rapid-fire guns of six-inch calibre. On the deck above and centrally below the turret, is located the handling room into which open by water-tight doors the magazines, where are stored the powder charges and the shells for the 12-inch guns above. Two decks above we come to the steel protective deck, 2½ to 3 inches in thickness. Upon this deck is erected a great circular structure known as the barbette, whose walls will be from eight to twelve inches in thickness. The barbette is actually a circular steel fort, and it is thick enough and its steel protection hard enough, to break up and keep out the heaviest projectiles of the enemy, except when they are fired at close ranges. At about two-thirds of the height of the barbette is a heavy circular track upon which runs a massive turntable. The framing of this turntable extends to a point slightly above the top edge of the barbette, and upon it is imposed the massive structure of the turret, which is formed, like the barbette, of heavy steel armor carried upon framing, the form of the turret in plan being elliptical. Its front face, which slopes at an angle of about 40 degrees, is pierced with two ports, through which project the two heavy 12-inch guns. The mounting of these guns is carried also upon the turntable and revolves with the turret. From the handling room below a steel elevator track extends up through the barbette and curves back to the rear of the gun; and upon this there travel two ammunition cages which are loaded below upon the handling room floor and carry the projectiles and powder up to the breech of the guns, where it is thrust into the gun by mechanical rammers.

## THE SUBMARINE MINE.

Broadly speaking, there are three different kinds of submarine mines. First, observation mines, which are fired from the shore when a ship is known to be in range; second, automatic mines, which are exploded on being struck by a ship, which is the kind with which the Russians claim that the "Petropavlovsk" was sunk; third, electric-contact mines, which on being struck by a passing vessel give notification to an operator on shore, who fires the mine by the throw of a switch.

The accompanying illustrations show a system of electric-contact

ground mines, laid across a channel, with a battery of rapid-fire guns on shore so placed that they command the whole of the mine field, and render it impossible for the small boats of the enemy to attempt to explode the mines before the big battleships and armored cruisers pass over them. The battery is placed rather low down near the water, and above it is a battery of heavy 8 and 10-inch breech-loading rifles mounted either *en barbette*, or on disappearing mounts, while above these, carefully masked by shrubbery, is a firing station, which is connected by cables with the mines in the channel. Sometimes, by preference, the firing station is placed in a massive concrete casemate, which is built into the structure of the fortification. The submarine mines would be laid out in a series of parallel lines, and so spaced that the mines in each line would cover the spaces left in the adjacent lines, with the result that on whatever course a ship might be steering, she would be certain to strike one or more of the mines before she passes over the field. The ground mine, which, as we have said, is usually a hemispherical metal case, contains several hundred pounds of high explosive, and is held in place on the bed of the river or channel by its own weight, sometimes assisted by heavy hooks cast upon the outer shell. Anchored to the mine, and floating above it, at a depth below water that is less than the draft of the enemy's vessels, is a hollow buoyant sphere in which is placed the electric circuit-closer. The second engraving of the two herewith shown represents a section through the floating sphere, and shows the details of a type of circuit-closer which has been very widely used. It consists of a horseshoe magnet, *M*, *M*, within which is hung by a coiled wire a ball, *B*. A silken cord is hung from the top of the magnet, passes down through the ball, and is attached to an armature, *A*. When the vessel strikes the buoy, the ball is thrown to one side, draws aside the silken cord and lifts the armature, *A*. To the poles, *N*, *S*, of the magnet are secured two small magnets, *C*, *C*, one end of the coil wire being connected to line and the other to a contact point, *b*. The armature *A* is secured by a spring to an insulated point, *P*, from which a wire passes through the firing fuse in the ground mine to earth. The other end of the armature carries a contact point

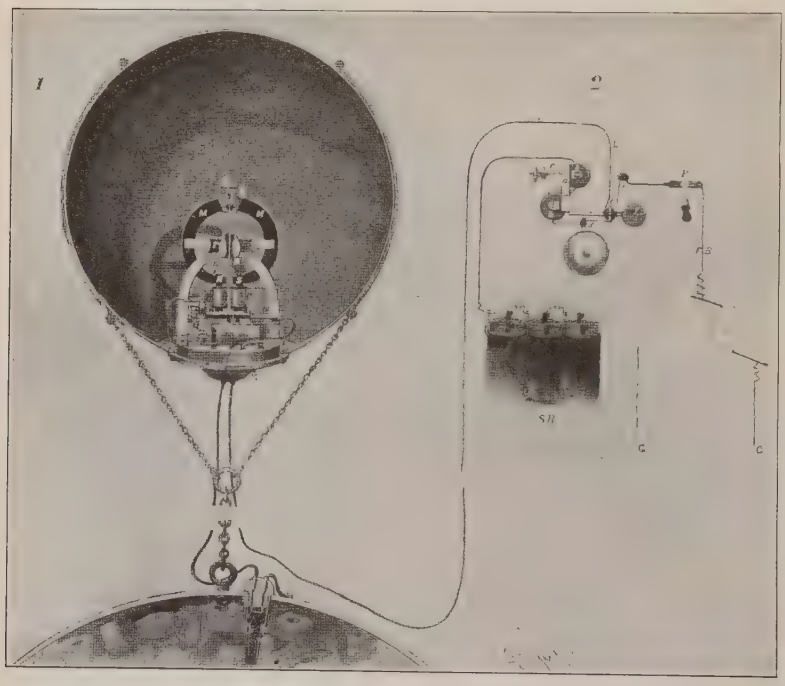
Field of ground mines, showing submerged electric-contact-floating buoys attached.
Rapid-fire battery to prevent countermining.
Battery of 8 and 10-inch disappearing guns.
Firing station and range-finders.

METHOD OF DEFENDING HARBOR CHANNEL WITH SUBMARINE MINES AND BATTERIES OF RAPID-FIRE AND HIGH-POWERED GUNS.

which, when the buoy is struck, engages with a contact point, *b*, which is connected to earth through the interposed resistance of a 1,000-ohm resistance coil.

Our second engraving shows the automatic indicator or shutter, which is placed in the firing station on shore.

Now let us follow more closely the operation of blowing up the hostile ship. The instant the vessel strikes the buoy, the suspended ball, *B*, swings to one side, draws aside the cord, pulls up armature *A*, into contact with *b*, and causes the signal-battery current to pass by way of the 1,000-ohm resistance-coil down through the ground fuse to earth. This current is too weak to ignite the fuse. At the same time the armature *a* (in the firing station), is attracted to the magnets, *b*, *b*, and releases the pivoted shutter, 4, ringing the bell and throwing the signal battery line *L* into circuit with the line to the firing battery, *F*, *B*. The operator now places the plug, *P*, in place, and sends the whole force of the main current into the line, and as this has sufficient force to pass the resistance and ignite the fuse, the ground mine is instantly exploded. In the case of an automatic mine of the kind that is claimed to have sunk the "Petropavlovsk," the instant the floating sphere or case is struck by the ship, there is an explosion of the charge, which is carried in the floating case, if the water is very deep, or in the ground mine at the bottom if the water is sufficiently shallow to bring the mine within striking distance of the ship's bottom.



GROUND MINE, ELECTRIC-CONTACT, BUOY, AND SHUTTER AT FIRING STATION.

## A GROUP OF NAVY PROJECTILES.

The projectiles in use by our navy may be classed as solid shot, shell and shrapnel. Although some excellent solid shot is still manufactured, such as the Johnson fluid compressed shot, solid shot have given place to shell as the standard projectiles of the navy.

8-inch 4-inch 10-inch 5-inch 12-inch 6-inch 13-inch

GROUP OF COMMON SHELL AT THE WASHINGTON NAVY YARD.

Shell is formed with an interior cavity of considerable dimensions, in which is placed a charge of powder or high explosive. It is provided with a fuse for the ignition of the charge, which is of the percussion or time-fuse type. The former acts at the instant of striking; the latter is set to explode the shell a certain length of time after the shell has left the muzzle of the gun.

Shrapnel is the modern form of the old case shot, which consisted of a large number of balls put up in a case or envelope, which merely served to hold them together until they left the muzzle of the gun. In the case of shrapnel the envelope is made sufficiently strong to bear the shock of discharge, and a time-fuse is provided.

The best armor-piercing projectiles

are now made of chrome steel, the small admixture of chromium serving to impart to the steel a remarkable amount of toughness. The projectiles are cast, forged, and carefully annealed and tempered, the hardening being confined to the point or nose. The latter is ogival in form, the point being struck with a radius which is two or three times the diameter of the shell. The point has to be sharply pointed to insure its penetration of the hard face of the armor, but if it is made too fine, it will lack the necessary resisting power and will be fractured before it can get through. The best proportion of radius is found to lie between two and three times the diameter.

There are two kinds of armor-piercing projectiles. The first is made solid, or practically so, a small core being formed to give the best results in the forging process; the other type is known as semi-armor-piercing. It is formed hollow, with a core of moderate dimensions, large enough to hold an explosive charge that will insure the bursting of the thick walls of the projectile. It is made of chrome steel, and requires in its manufacture to be treated with great care to secure the combined hardness and toughness to enable it to pierce solid armor without fracturing and carry its explosive charge intact into the interior of the ship. When such shell is filled with common powder the heat engendered by passing through the armor is depended on to explode the shell just within the ship; no fuse is used.

The object at which projectile makers are aiming just now is to make a shell which can carry a charge through the best armor and burst on the inner side of the armor. It is already possible to put solid shot through plate that is as much as one and one-half the diameter of the shot in thickness, and the success of the projectile makers is such as to make it likely that before long a bursting shell can be made to perform the same feat.

It will be evident that penetration of the armor belt by a shell will be vastly more destructive to the ship than penetration by solid shot. The damage wrought by the latter will be confined to its direct path, where the zone of destruction of a shell will be almost as extensive, if it is of the larger calibres, as the whole area of the deck on which it strikes. The effects, moreover, will be greatly augmented if a high-explosive, bursting charge be substituted for common powder, although the sensitiveness of such charges renders it very difficult to carry them through armor plate and burst them on the inside. Excellent results, however, have been achieved in this direction against armor of moderate thickness.

The group of shells shown in our engraving includes one of each of the sizes used on our warships, from the 4-inch 33-pound shell up to the 13-inch 1,100-pound shell of our largest guns. They are all of the class known as "common shell," and are used against fortifications and earthworks and against the unarmored or lightly armored portions of warships. They are usually formed of cast-iron, though sometimes of cast-steel, and the interior cavity is large, enabling a big bursting charge to be carried. Unlike the forged chrome steel shell, they are unfit for armor-piercing, not having the necessary strength to carry them through the plates.

The particulars of these shells are given in the following table:

| Diameter. | Length. | Bursting Charge. |
|---|---|---|
| 4-inch..... | 1 foot 4 inches. | 2 pounds. |
| 5 " ..... | 1 " 3 " | 3 " |
| 6 " ..... | 1 " 9 " | 4 " |
| 8 " ..... | 2 " 6 " | 10 " |
| 10 " ..... | 3 " 0 " | 22 " |
| 12 " ..... | 3 " 8 " | 42 " |
| 13 " ..... | 4 " 0 " | 70 " |

It will be noticed that the point of the shell is cut off. It is here that the percussion fuse is inserted. The fuse consists of a hollow threaded brass case, which is screwed into a hole bored through into the interior of the shell. Inside the case is a cylindrical lead plunger, in the center of which is a fulminate and a priming charge. When the gun is fired, the plunger moves to the rear of the fuse, and at the moment when the shell strikes an obstruction it flies forward, the fulminate striking a small anvil on the fuse cap. This ignites the primer, the flame of which enters the shell and explodes it.

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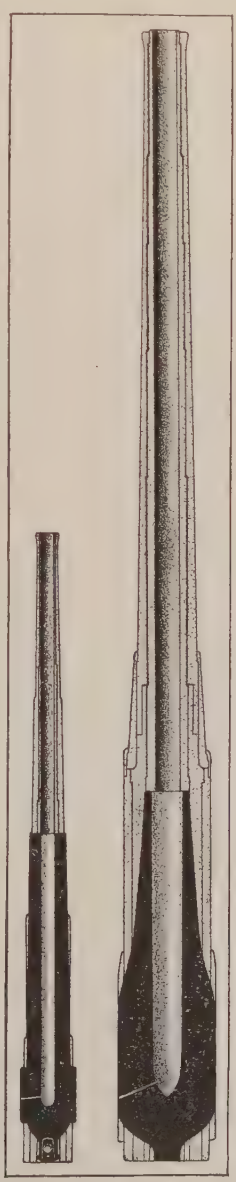
Turkestan is a general government of Central Asia. It comprises the khanates and deserts annexed by Generals Tchernaieff and Kaufmann between 1860 and 1875, and now known as the provinces of Samarcand, Ferghana, and Syr Daria. Area about 257,134 square miles, with 3,900,000 inhabitants.

## OUR NAVY GUNS IN THE CIVIL WAR AND TO-DAY.

Naval ordnance has made greater strides in the forty years that have intervened since the Civil War than in several centuries preceding. As proof of this it is enough to look at the striking comparison shown in the accompanying cut. The smaller illustration represents a Parrott 100-pounder of 1862, superimposed upon a modern 100-pounder, or to be correct, a 6-inch 50-calibre rapid-fire rifle of the year 1900; the lower diagram represents a 15-inch smooth-bore of the Civil War, superimposed upon a 12-inch breech-loading 45-calibre rifle of to-day. The comparison might be carried out to greater length throughout all the various calibres that constitute the batteries of naval ships; but we have chosen to compare the main battery of the monitor with the main battery of the modern battleship, and what might be called the secondary battery of the frigates of 1862 with the standard secondary battery gun of the battleship of to-day.

The heaviest piece carried in the Civil War was the 15-inch smooth-bore. This gun weighed 42,000 pounds; its length over all was 15 feet 1 inch; its maximum diameter at the breech was 4 feet, and with an ordinary charge of 35 pounds of black cannon powder, it fired a spherical shell weighing 350 pounds. According to the ordnance regulations, under extraordinary conditions, these guns might be fired 20 rounds "at ironclads at close quarters," using 100 pounds of hexagonal or cubical powder and a solid shot weighing 450 pounds. Under these conditions the most respectable muzzle velocity of 1,600 foot-seconds was obtained, with a corresponding muzzle energy of 7,997 foot-tons. It would be interesting to know what the powder pressure was under these conditions, for the velocity and energy are something truly remarkable for a cast-iron gun. It is little wonder that only 20 rounds were allowed under the severe stresses imposed by these ballistics.

Now, compare these results with the most powerful gun in our navy to-day, namely, the 12-inch 45-calibre rifle, which weighs 53.4 tons, has a total length of 45 feet, and with a charge of 360 pounds of smokeless powder fires an 850-pound shell with a muzzle velocity of 2,800-foot seconds and a muzzle energy of 46,246 foot-tons. The true basis of comparison of the



The Parrott 100-pounder rifle and the 15-inch smooth bore (period of Civil War), compared with the 50-calibre 6-inch and the 45-calibre 12-inch rifles of 1902. Civil War guns are shown in black.

OUR NAVAL GUNS IN THE CIVIL WAR AND TO-DAY.

relative efficiency of the two guns is the amount of energy developed per ton of the weight of the gun, and on this basis we find that the old 15-inch smooth-bore gun when fired with 100 pounds of powder developed 427 foot-tons of energy per ton of gun, as against 872 foot-tons of energy developed by the modern 12-inch rifle.

If we take account of the durability of a gun the advantage will be stronger on the side of the modern piece, for whereas the 15-inch smooth-bore was limited to twenty rounds under the given conditions, the modern 12-inch rifles, judging from the small amount of erosion developed with nitro-cellulose powders, should have a useful life of at least half a thousand rounds. Moreover, it must be remembered that the modern elongated shell will hold its velocity much longer than the old spherical shell of the smooth-bore, and, consequently, the respective muzzle velocities and energies are no criterion of the respective efficiencies of the guns.

The gun of 1862 that answers to the modern secondary battery, 6-inch rifle, is the Parrott muzzle-loading rifle, a cast-iron gun which was strengthened at the breech over the powder chamber by shrinking thereon an iron hoop. The bore of the gun was 6.4 inches. It weighed 4.35 tons, was 12 feet 4 inches in length and with a charge of ten pounds of powder it fired a 100-pound shell with an initial velocity of 1,080 foot-seconds and a muzzle energy of 810 foot-tons. Compare this with the modern 6-inch rifle, which weighs 8.5 tons, is 25 feet in length, and with a charge of 40 pounds of smokeless powder fires a 100-pound shell with an initial velocity of 2,900 feet per second and an initial energy of 5,838 foot-tons.

Compared on the basis of energy per ton of gun, we find that the 100-pounder Parrott muzzle loader developed 186 foot-tons of energy per ton of gun, whereas the modern 6-inch breech-loading rifle develops 784½ foot-tons of energy per ton of gun.

## THE PAY OF NAVAL AND MARINE CORPS.

An Admiral receives $13,500 whether on sea duty or on shore duty. The first nine Rear-Admirals receive $7,500 while on sea duty, and $6,375 on shore duty. The second nine receives $5,500 on sea duty and $4,675 on shore duty. A Brigadier-General Commandant of Marine Corps, receives $5,500. The Chiefs of the various Naval Bureaus receive $5,500. Captains of the Navy receive $3,500 while on sea duty and $2,975 while on shore duty. The Judge Advocate General and Colonels, Marine Corps, line and staff, receive $3,500. Commanders of the Navy receive $3,000 while on sea duty, and $2,550 while on shore duty. Lieut.-Colonels, Marine Corps, line and staff, receive $3,000. Lieut.-Commanders of the Navy while on sea duty receive $2,500, and while on shore duty $2,125. Majors of the Marine Corps, line and staff, receive $2,500. Lieutenants of the Navy receive $1,800 while on sea duty and $1,530 while on shore duty. Captains of the Marine Corps, if they are of the line, receive $1,800, and if they are of the staff, $2,000. Lieutenants of the junior grade receive $1,500 while on sea duty and $1,275 while on shore duty. First Lieutenant and leader of the band of the Marine Corps receive $1,500. Ensigns of the Navy receive $1,400 on sea duty and $1,190 on shore duty. Second Lieutenants of the Marine Corps, Chief Boatswains, Chief Gunners, Chief Carpenters and Chief Sailmakers receive $1,400. Midshipmen in other than practice ships receives $950. At the Naval Academy and elsewhere $500. Chaplains receive $2,500 on sea duty, $2,000 on shore, and $1,900 on leave or waiting orders. Professors of Mathematics and Civil Engineers receive $2,400 and $1,500 when on leave of absence or waiting orders. Naval Constructors receive $3,200, and while on leave of absence or waiting orders, $2,200. Assistant Naval Constructors receive $2,000, and $1,500 while on leave or waiting orders. The warrant officers, boatswains, gunners, carpenters, sailmakers, pharmacists and warrant machinists receive $1,200 while on sea duty and $900 while on shore, $700 on leave of absence or waiting orders. Mates who were in service August 1, 1904, receive $1,200 for sea duty, $900 for shore duty, $700 on leave. Those appointed since receive $900, $700 and $500 respectively. The monthly pay of petty officers and enlisted men is: Chief petty officers, $50 to $70; petty officers, first-class, $36 to $65; petty officers, second-class, $35 to $40; third-class petty officers, $30; first-class seamen, $21 to $35; second-class seamen, $15 to $30; third-class seamen, $9 to $22.

# CHAPTER IV.

## ARMIES OF THE WORLD.

Twice in the history of the world we have had an example of large bodies of men who were not producers who disturbed economic conditions by living at the public expense. We refer to the enormous monasteries in the middle ages and to the standing armies in Europe to-day. It seems to be essential to the maintenance of the integrity of a number of the countries of Europe to keep a large standing army—an army which takes some of the best years of the life of its citizens, as service is obligatory to all. These armies are supported at an enormous expense by systems of taxation which affect the poorest as well as the richest.

The question of the standing armies of Europe is a problem which is rapidly increasing in seriousness, and there does not appear as yet to be any solution of the difficulty.

For our protection we have to rely upon:

1. The Regular Army, which represents and is under the pay of the federal government, and which is officered: 1. By graduates of the United States Military Academy, who at present are largely in the minority. 2. By the promotion of meritorious enlisted men of the Army. 3. By the appointment of civilians, six of whom are annually selected from the best cadet-schools of the country. The last class is at present most largely represented.

The officers receive commissions at the hands of the President.

2. The organized militia or National Guard, which is composed exclusively of State troops, and, except when called into the service of the United States, is under the command of the Governors of the respective States. The officers of higher grade are appointed by the Governors, but the other officers, from Colonel down, are generally selected by ballot by the troops themselves. The National Guard is intended primarily for home defense.

3. The Volunteers, which form a branch of the service only to be found in time of war. They are such as offer their services upon the call of the President, and are officered either by West Point graduates, by officers of the National Guard, or civilian appointees.

Under the conditions existing in the late war with Spain, members of the National Guard were not called upon to serve in their capacity as State troops, but were invited to enlist in the volunteer service.

The term of enlistment in the regular service is for a period of three years, which term is fixed and not terminable by the ending of the war. In the volunteer service the period of enlistment is two years, but this term may be shortened by the ending of hostilities.

A certain proportion of the officers of the regular army are graduates of the United States Military Academy at West Point, New York.

By Acts of Congress approved June 6, 1900, June 28, 1902, and March 3, 1903, the Corps of Cadets as now constituted consists of one from each Congressional district, one from each Territory, one from the District of Columbia, one from Porto Rico, two from each State at large, and forty from the United States at large, all to be appointed by the President and, with the exception of the forty appointed from the United States at large, to be actual residents of the Congressional or Territorial districts, or of the District of Columbia, or of the States, respectively, from which they are appointed. Under these Acts, and under the apportionment of Members of Congress according to the 12th Census, the maximum number of cadets is 522.

The total number of graduates from 1802 to 1903, inclusive, is 4,214; 124 members graduated June 15, 1904.

Foreign governments can have cadets educated at the academy by authorization of Congress.

GROUP OF OFFICERS AND MEN OF THE UNITED STATES ARMY, SHOWING UNIFORMS.

GROUP OF OFFICERS AND MEN SHOWING UNIFORMS WORN IN UNITED STATES ARMY.

1. Major of Engineers in olive-drab uniform.
2. Captain of Ordnance in olive-drab uniform.
3. Private of Cavalry in olive-drab uniform.
4. First Sergeant of Artillery in olive-drab uniform.
5. Private of Infantry in olive-drab uniform and clothing roll.
6. First Sergeant of Cavalry in olive-drab uniform.
7. Corporal of Post Artillery in olive-drab uniform and overcoat.
8. Post Quartermaster-Sergeant in olive-drab uniform.
9. Trumpeter of Cavalry, mounted, in full-dress uniform.
10. Colonel of Infantry, mounted, in full-dress uniform.
11. Major-General, mounted, in full-dress uniform.
12. Lieutenant-Colonel of Artillery, Aide-de-Camp, mounted, in full-dress uniform.
13. First Sergeant of Infantry, in full-dress uniform.
14. Captain of Cavalry, dismounted, in full-dress uniform.
15. Brigadier-General, dismounted, in dress uniform.
16. Major, Medical Department, dismounted, dress uniform and cape.
17. Corporal of Engineers, full-dress uniform.
18. Private of Cavalry, full-dress uniform.
19. Sergeant of Artillery in full-dress uniform.
20. Post Commissary-Sergeant, dress uniform.
21. Lieutenant of Cadets, U. S. Military Academy, full-dress uniform.
22. Major, Quartermaster's Department, in full-dress uniform.
23. First-class Sergeant, Signal Corps, in full-dress uniform.
24. Captain Coast Artillery, in dress uniform and overcoat.

The commander-in-chief is, ex-officio, of course, the President of the United States.

Like the grades of Admiral and Vice-Admiral, the army also has two grades—General and Lieutenant-General. We have had only four Generals, Washington, Grant, Sherman and Sheridan. A general is supposed to command an army. An army is a large and organized body of soldiers generally composed of infantry, artillery and cavalry, completely armed and provided with necessary stores, etc., and the entire force is under the direction of one general, who is called the "general-in-chief." The army is subdivided as follows; the grades of rank and commands appropriate to each grade are given.

An "army" is divided into two or more corps commanded by a Major-General. A "corps" is "the largest tactical unit of a large army. A corps is usually organized with separate staff, infantry, cavalry, and artillery regiments, as well as auxiliary services, so that it is really a small army complete in itself. A corps is usually composed of three divisions, each commanded by a Major-General or a Brigadier-General. A "corps" is also any body or department of an army which is not detached, but has its own organization and head, as the "Corps of Engineers." Each "division" is composed of three brigades, and there may be an independent brigade of cavalry or artillery called the divisional cavalry or artillery.

A "brigade" consists of three regiments, though there may be more, and it is commanded by a Brigadier-General, and sometimes by a Colonel. A "regiment," which is the administrative unit, is commanded by a Colonel, and it is divided into twelve companies, each composed, under the present law, of a maximum of 150 men for the infantry, 100 men for the cavalry, a total of 18,920 for the artillery corps, and 150 men for the engineers. A "company" is commanded by a Captain. Two or more companies form a "battalion," and the battalion is commanded by a Major.

The relative rank between the officers of the army and navy is as follows: General with Admiral; Lieutenant-General with Vice-Admiral; Major-General with Rear-Admiral; Brigadier-General with Commodore; Colonel with Captain; Lieutenant-Colonel with Commander; Major with Lieutenant-Commander; Captain with Lieutenant; First Lieutenant with Lieutenant (junior grade); Second Lieutenant with Ensign.

The pay of the officers in active service is as follows: Lieutenant-General, $11,000; Major-General, $7,500; Brigadier-General, $5,500; Colonel, $3,500; Lieutenant-Colonel, $3,000; Major, $2,500; Mounted Captain, $2,000; Captain on foot, $1,800; regimental Adjutant, $1,800; regimental Quar-

termaster, $1,800; First Lieutenant, mounted, $1,600; First Lieutenant on foot, $1,500; Second Lieutenant, mounted, $1,500; Second Lieutenant on foot, $1,400. All of the officers from the Colonel down receive additional amounts after five, ten, fifteen and twenty years service, but there is a limit to this amount; thus the maximum pay of a Colonel is $4,500 per annum. The pay of a private, whether artillery, cavalry or infantry, is $13 per month for the first and second years, $14 for the third year, $15 for the fourth year, $16 for the fifth year. After five years' continuous service they receive $2 per month extra. For service in the insular possessions 20 per cent. is added to the pay of officers and enlisted men.

The strength of the regular army on February 28, 1905, was 3,836 officers and 63,224 enlisted men; of these, 695 officers and 10,249 men were stationed in the Philippines. This does not include 100 officers and 4,498 men of the Philippine Scouts, paid by the United States Government, nor the Philippine Constabulary, which is paid from the Philippine treasury.

The policy of the United States in having a comparatively small military establishment has led to the organization of a "First Reserve," known as the organized militia, or National Guard. According to the returns received at the office of the Military Secretary for December 31, 1904, the strength of the militia of the various States and Territories was 9,151 commissioned officers and 111,764 enlisted men, a total of 120,915.

Under the Act of Congress approved January 31, 1903, the militia consists of every able-bodied male citizen of the United States who is more than eighteen and less than forty-five years of age, and is divided into two classes—the organized militia or National Guard, and the remainder to be known as the reserve militia. It is entirely optional whether eligible citizens join the National Guard or not, and they elect their own officers, but it is safe to say that this body of reserves is recruited from the best and most patriotic element of the population of the United States. Congress makes an appropriation each year for the support of the militia in the various States, and the States also contribute, help and build armories, as the regiments are really intended to defend their own States primarily, although in time of war they furnish an excellently drilled body of volunteers. In nearly every city of any great size there is one or more armories, and in the smaller cities and towns there are separate companies which have armories or drill halls. The militia in each State is divided into brigades, regiments and companies. Under the act of Congress above named the President of the United States has the power to call upon any of the military organizations of the States for national defense, but the troops are usually utilized by the Governor of the State for enforcing the State laws.

The experience of the Spanish-American war demonstrated the need of what is known in foreign armies as a General Staff Corps. Accordingly, under the Act of Congress approved February 14, 1903, a Chief of Staff was authorized, to take the place of the commanding general of the army, and a General Staff Corps whose duties are defined as follows: To prepare plans for the national defense and for the mobilization of the military forces in time of war; to investigate and report upon all questions affecting the efficiency of the army and its state of preparation for military operations; to render professional aid and assistance to the Secretary of War and to general officers and other superior commanders, and to act as their agents in informing and co-ordinating the action of the different officers who, under the terms of the act, are subject to the supervision of the Chief of Staff; and to perform such other military duties not otherwise assigned by law, as may from time to time be prescribed by the President.

Under this act a number of officers were detailed in the General Staff for a period of four years, and the corps was organized into three divisions, each under a superior officer, with the following duties: The first division has charge of army administration, discipline, drill, and equipment; the second division is the division of military information, and in addition has charge of military maps, military attaches and the War Department library: the third division is termed the technical division, and includes the devising of plans for defense and offense, the matter of sites for fortifications, the question of military education, and the Army War College.

# INFORMATION RELATIVE TO THE APPOINTMENT AND ADMISSION OF CADETS TO THE UNITED STATES MILITARY ACADEMY.

## APPOINTMENTS.

How Made.—Each Congressional District and Territory—the District of Columbia and also Porto Rico—is entitled to have one Cadet at the Academy. Each State is also entitled to have two Cadets from the State at large, and forty are allowed from the United States at large. The appointment from a Congressional District is made upon the recommendation of the Congressman from that district, and those from a State at large upon the recommendations of the Senators of the State. Similarly the appointment from a Territory is made upon the recommendation of the Delegate in Congress. Each person appointed must be an actual resident of the State, District or Territory from which the appointment is made.

The appointments from the United States at large, from the District of Columbia and from Porto Rico are made by the President of the United States upon his own selection. The appointment of the Cadet from Porto Rico is made by the President on the recommendation of the Resident Commissioner.

Manner of Making Applications.—Applications may be made at any time, by letter to the Adjutant General, U. S. Army, Washington, D. C., to have the name of the applicant placed upon the register that it may be furnished to the proper Senator, Representative, or Delegate, when a vacancy occurs. The application must exhibit the full name, date of birth, and permanent abode of the applicant, with the number of the Congressional District in which his residence is situated.

Date of Appointments.—Appointments are required by law to be made one year in advance of the date of admission, except in cases where, by reason of death or other cause, a vacancy occurs which cannot be provided for by such appointment in advance. These vacancies are filled in time for the next examination.

Alternates.—For each candidate appointed there may be nominated *two alternates*. The principal and each alternate will receive from the War Department a letter of appointment, and must appear for examination at the time and place therein designated; those previously accepted by Academic Board on certificate or mentally qualified, appearing for physical examination only.

The fitness for admission to the Academy of the principal and the alternates will be determined as prescribed in paragraphs 19, 20 and 21, Regulations U. S. Military Academy.

Should the principal and alternates not qualify for admission under the provisions of paragraph 21, they will still be entitled to appear for the examination prescribed in paragraph 19; but if the principal fails to appear for that examination or, appearing, fails to qualify, then the qualifications of the alternates will be considered and if only one has met the requirements he will be admitted; if both alternates have met the requirements the better qualified will be admitted.

The alternates, like the principal, should be designated as nearly one year in advance of the date of admission as possible.

## ADMISSION OF CANDIDATES.

The following are extracts from the regulations of the Military Academy relating to the examination of candidates for admission and will be strictly adhered to:

19. Candidates selected for appointment, unless accepted under the provisions of paragraph 21, shall appear for mental and physical examination before boards of army officers to be convened at such places as the War Department may select, on the first of May, annually, except when that day comes on Sunday, in which case the examination shall commence on the following Tuesday. Candidates who pass successfully will be admitted to the Academy without further examination upon reporting in person to the Superintendent at West Point before 12 o'clock noon on the 15th day of June of the same year.

20. Each candidate before he shall be admitted to the Academy as a Cadet must show, by the examination provided for in paragraph 19 or by the methods prescribed in paragraph 21,

that he is well versed in the following prescribed subjects, viz.: Reading, writing, spelling, English grammar, English composition, English literature, arithmetic, algebra through quadratic equations, plane geometry, descriptive geography, and the elements of physical geography, especially the geography of the United States, United States history, the outlines of general history, and the general principles of physiology and hygiene.

21. The Academic Board will consider and may accept in lieu of the regular mental entrance examination:

1st. The properly attested examination papers of a candidate who receives his appointment through a public competitive written examination covering the range of subjects prescribed in paragraph 20.

2d. The properly attested certificate of graduation from a public high school or a State normal school in which the course of study, together with the requirements for entrance, shall cover the range of subjects prescribed in paragraph 20.

3d. A properly attested certificate that the candidate is a regular student of any incorporated college or university, without condition as to any subject mentioned in paragraph 20.

Application for consideration of papers or certificates shall be made by each candidate and alternate immediately after he receives his appointment. No application will be received after March 15 preceding the regular examination prescribed in paragraph 19.

Candidates accepted as qualified mentally under the provisions of this paragraph shall appear for physical examination at the time and place designated in their letters of appointment.

Immediately after reporting to the Superintendent for admission, and before receiving his warrant of appointment, the candidate is required to sign an engagement for service in the following form, and in the presence of the Superintendent, or of some officer deputed by him:

"I, —— ——, of the State (or Territory) of ——, aged —— years —— months, do hereby engage (with the consent of my parent or guardian) that, from the date of my admission as a Cadet of the United States Military Academy, I will serve in the Army of the United States for eight years, unless sooner discharged by competent authority.

"In the presence of —— ——."

The candidate is then required to take and subscribe an oath or affirmation in the following form:

"I,—— ——, do solemnly swear that I will support the Constitution of the United States, and bear true allegiance to the National Government; that I will maintain and defend the sovereignty of the United States, paramount to any and all allegiance, sovereignty, or fealty I may owe to any State or country whatsoever; and that I will at all times obey the legal orders of my superior officers, and the rules and articles governing the Armies of the United States.

"Sworn and subscribed, at ——, this —— day of —— nineteen hundred and —— before me.

—— ——."

Qualifications.—No candidate shall be admitted who is under seventeen, or over twenty-two years of age, or who is deformed, or afflicted with any disease or infirmity which would render him unfit for the military service, or who has, at the time of presenting himself, any disorder of an infectious or immoral character. Accepted candidates if between seventeen and eighteen years of age should not fall below five feet three inches in height and one hundred pounds in weight; if between eighteen and nineteen years, five feet three and one-half inches in height and one hundred and five pounds in weight; if over nineteen, five feet four inches in height and one hundred and ten pounds in weight. Candidates must be unmarried.

Each candidate must on reporting at West Point present a certificate showing successful vaccination within one year; or a certificate of two vaccinations, made at least a month apart, within three months.

A circular of information as to the physical and mental examination can be had by addressing the Secretary of War, Washington, D. C.

### ACADEMIC DUTIES.

The academic duties and exercises commence on the first of September and continue until the first of June.

Examinations of the several classes are held in December and June, and, at the former, such of the new Cadets as are found proficient in studies and have been correct in conduct are given the particular standing in their class to which their merits entitle them. After each examination, Cadets found deficient in conduct or studies are discharged from the Academy, unless the Academic Board for special reasons in each case should otherwise recommend. Similar examinations are held every December and June during the four years comprising the course of study.

Military Instruction.—From the termination of the examination in June to the end of August the Cadets live in camp, engaged only in military duties and exercises and receiving practical military instruction.

Except in extreme cases, Cadets are allowed but one leave of absence during the four years' course; as a rule the leave is granted at the end of the first two years' course of study.

### PAY OF CADETS.

The pay of a Cadet is $500 per year and one ration per day, or commutation therefor at thirty cents per day. The total is $609.50, to commence with his admission to the Academy. The actual and necessary traveling expenses of candidates from their homes to the Military Academy are credited to their accounts *after* their admission as Cadets. There is no provision for paying the expenses of candidates who fail to enter and they must be prepared to defray all their own expenses.

No Cadet is permitted to receive money, or any other supplies, from his parents, or from any person whomsoever, without the sanction of the Superintendent. A *most rigid* observance of this regulation is urged upon all parents and guardians, as its violations would make distinctions between Cadets which it is the especial desire to avoid; the pay of a Cadet is sufficient, with proper economy, for his support.

Each Cadet must keep himself supplied with the following mentioned articles, viz.:

Two pairs of uniform shoes; six pairs of uniform white gloves; two sets of white belts; *eight white shirts; *four night shirts; twelve white linen collars; twelve pairs of white linen cuffs; *eight pairs of socks; *eight pairs of summer drawers; *six pairs of winter drawers; *twelve pocket handkerchiefs; *twelve towels; two clothes bags, made of ticking; *one clothes brush; *one hairbrush; *one tooth brush; *one comb; one mattress; one pillow; four pillowcases; eight sheets, two blankets, and one quilted bed cover; one chair; one tumbler; *one trunk; one account book; one wash basin.

Candidates are authorized to bring with them the articles marked *.

Cadets are required to wear the prescribed uniform. All articles of their uniform are of a designated pattern, and are sold to Cadets at West Point at regulated prices.

### DEPOSIT PRIOR TO ADMISSION.

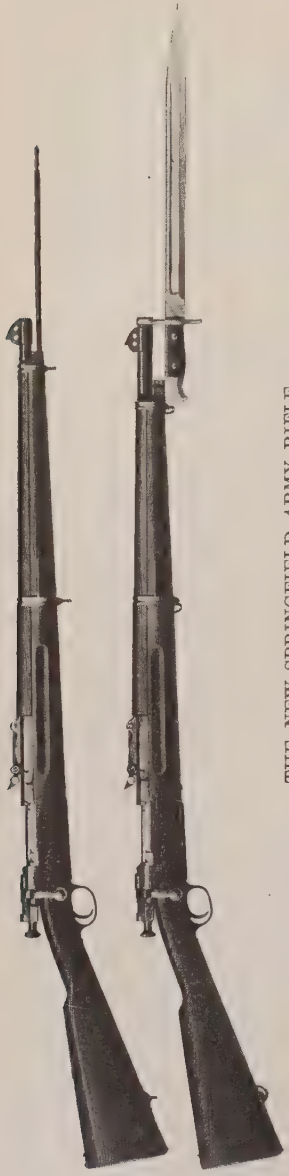
Immediately after being admitted to the Institution, Cadets must be provided with an outfit of uniform, the cost of which will be about $100, *which sum must be deposited with the Treasurer of the Academy before the candidate is admitted.* It is best for a candidate to take with him no more money than will defray his traveling expenses, and for the parent or guardian to send to "*The Treasurer of the U. S. Military Academy*," the required deposit of $100. This amount is sufficient to equip a new Cadet with uniform and to supply him with all articles and books.

### PROMOTION AFTER GRADUATION.

The attention of applicants and candidates is called to the following provisions of an Act of Congress approved May 17, 1886, to regulate the promotion of graduates of the United States Military Academy:—

"That when any Cadet of the United States Military Academy has gone through all its classes and received a regular diploma from the Academic Staff, he may be promoted and commissioned as a second lieutenant in any arm or corps of the army in which there may be a vacancy and the duties of which he may have been judged competent to perform; and in case there shall not at the time be a vacancy in such arm or corps, he may, at the discretion of the President, be promoted and commissioned in it as an additional second lieutenant, with the usual pay and allowances of a second lieutenant, until a vacancy shall happen."

## SPRINGFIELD MAGAZINE RIFLE.



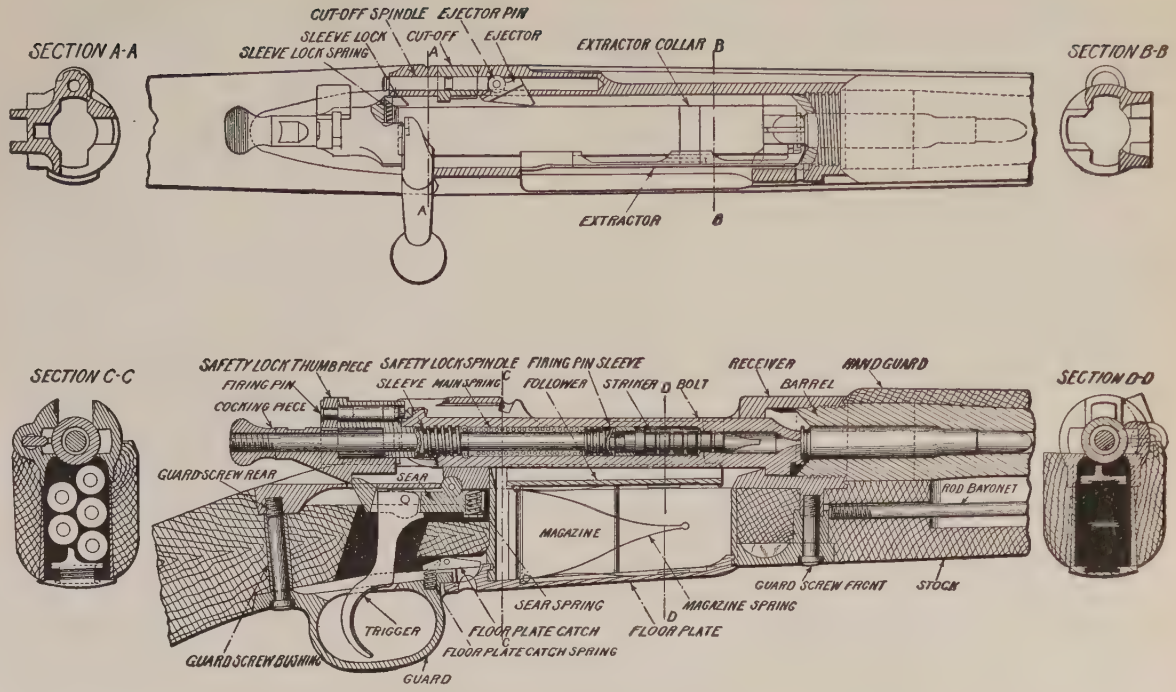
THE NEW SPRINGFIELD ARMY RIFLE.

Showing the discarded rod bayonet and the formidable sword bayonet which has been adopted.

Muzzle velocity, 2,300 feet per second. Weight of bullet, 220 grains. Weight of charge, 43.3 grains.

How greatly wide of the mark academic discussions of military matters may lead us, has been well illustrated in the matter of the United States army bayonet. The increased range and great accuracy of the modern rifle, and the good use of it made by the Boer sharpshooters in their late war, had led to the belief that in future wars fighting would be carried out at so great a range that the bayonet would seldom be brought into use. It was considered that the losses by an attacking party would be so great that they could never, or at least very rarely, hope to take intrenchments by storm and turn the enemy out by hand-to-hand fighting. Our own ordnance officers were so much impressed with these supposed facts, that in the new Springfield army rifle, which was being manufactured at the time of the opening of the Russo-Japanese war, the bayonet was practically abandoned and a small, round steel rod, about a quarter of an inch in diameter, substituted in its place. The rod was a perfectly useless element in the rifle, being too weak for hand-to-hand fighting—indeed, its existence in the rifle at all must be looked upon as a concession to long-established habit.

The Russo-Japanese war has taught us that the bayonet is by no means an obsolete weapon. In the fierce fighting at Port Arthur it was used freely both by day and night. Positions were taken, retaken, taken again, to be retaken once more, and in every case the work was done in hand-to-hand fighting, and with the bayonet. The estimate as to the losses that attacking troops will stand before they break and retreat, has been shown, at least in the case of Japanese troops, to be entirely at fault. An attack that lost twenty-five per cent. of its forces was supposed to end in failure; but the Japanese have lost twice and three times that number in the face of a most murderous machine gun and rifle fire, and the remnant has swept on to turn the enemy out of the trenches at the point of the bayonet. The evolution of the United States army rifle, during the past two years, is shown in the accompanying illustrations. The original pattern of the new Springfield army rifle, designed to replace the Krag-Jorgensen, was built with a 30-inch barrel and it was provided with a ¼-inch-diameter round steel rod, which took the place of the ordinary




DETAILS OF THE NEW SPRINGFIELD ARMY RIFLE.

bayonet or sword of triangular shape. This piece had a velocity of 2,300 feet per second, and it fired a 220-grain bullet with a charge of 43.3 grains of powder. In addition to having the highest velocity, it was the lightest of the best-known military rifles. Since the rifle was light and its energy unusually high, with such a heavy charge the recoil was, of course, excessive; and this was one of the objections urged against the new type. The wear on the rifling is also very severe. The ballistics of the piece, however, are exceptionally fine, its maximum ordinate for a 1,000-foot range being only 20.6 feet, as against 25.8 feet for the Krag-Jorgensen.

Five thousand of the Springfield rifles with the 30-inch barrel were ordered for trial in the field; but while these were under construction, the Ordnance Board decided to design one that could be issued to both branches of the service, cavalry and infantry. Accordingly they cut off 6 inches from the barrel, reduced it to 24 inches, or 2 inches longer than the cavalry carbine. They carried the hand protection from the middle band, at which it stopped in the 30-inch barrel type, up to the second band, thus practically covering the whole barrel. This piece also had the rod bayonet, which was carried permanently below the barrel in the position occupied by an ordinary ramrod in the old muzzle-loading musket. The rod, it should be mentioned, was provided with a catch, which enabled it to be drawn forward until several inches of it projected beyond the muzzle for use as a bayonet.

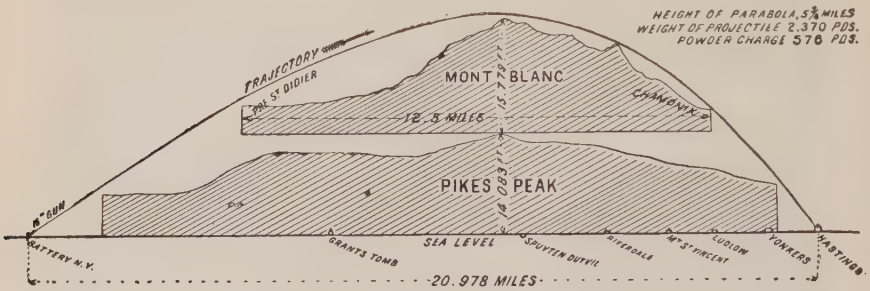
NEW SPRINGFIELD MAGAZINE RIFLE COMPARED WITH THE KRAG-JORGENSEN, THE MAUSER AND THE GERMAN MILITARY RIFLE.

| Data. | Springfield Magazine Rifle. | Service Magazine Rifle. | Mauser 7 Mm. Rifle. | German Military Rifle. |
|---|---|---|---|---|
| Caliber.....inch.. | 0.30 | 0.30 | 0.275 | 0.311 |
| Rifling: | | | | |
| Number of grooves..... | 4 | 4 | 4 | 4 |
| Depth of grooves.....inch.. | 0.004 | 0.004 | 0.0049 | 0.004 |
| Twist, one turn in.....inches.. | 10 | 10 | 8.66 | 9.45 |
| Weight of bullet.....grains.. | 220 | 220 | 173 | 226.82 |
| Weight of charge.....grains.. | 43.3 | 37.6 | 38.58 | 41.2 |
| Weight of complete cartridge.....grains.. | 451.15 | 438.85 | 385.63 | 430.24 |
| Initial velocity, feet per second..... | 2300 | 2000 | 2200 | 2145 |
| Remaining velocity at 1,000 yards..... | 958 | 901 | 895 | 906 |
| Muzzle energy.....foot-pounds.. | 2581.6 | 1952 | 1857.4 | 2135 |
| Striking energy at 1,000 yards. .foot-pounds.. | 447.9 | 396.2 | 307.4 | 413 |
| Penetration in white pine at 53 feet..inches.. | 54.7 | 45.8 | 50.8 | ..... |
| Weight of rifle, including bayonet and scabbard.....pounds.. | 9.47 | 10.64 | 10.5 | 11.54 |
| Weight of rifle, including bayonet, scabbard, and 100 cartridges.....pounds.. | 15.91 | 16.91 | 16.18 | 17.68 |
| Capacity of magazine.....rounds.. | 5 | 5 | 5 | 5 |
| Maximum ordinate of 1000 yd. trajectory, feet.. | 20.67 | 25.8 | 24.47 | 23.73 |

## THE SIXTEEN-INCH GUN.

The great 16-inch 126-ton gun, built for the United States at the Watervliet arsenal, is 49¼ feet long, over 6 feet in diameter at the breech, and it has an extreme range of over twenty miles. Its projectile weighs 2,370 pounds, and costs $865 to fire the gun once. The map on page 102 will give graphic illustration of the range of this gun. If fired at its maximum elevation from the battery at the south end of New York in a northerly direction, its projectile would pass over the city of New York, over Grant's Tomb, Spuyten Duyvil, Riverdale, Mount St. Vincent, Ludlow, Yonkers, and would land near Hastings-on-the-Hudson, nearly twenty miles away, as shown in our map. The extreme height of its trajectory would be 30,516 feet, or nearly six miles. This means that if Pike's Peak, of the Western Hemisphere, had piled on top of it Mont Blanc, of the Eastern Hemisphere, this gun would hurl its enormous projectile so high above them both as to still leave space below its curve to build Washington's Monument on top of Mont Blanc, as shown. The model, page 101, was exhibited at St. Louis.

MODEL OF THE 16-INCH GUN, EXHIBITED AT THE LOUISIANA PURCHASE EXPOSITION, ST. LOUIS, 1904.




RANGE OF SIXTEEN-INCH GUN.
Height of parabola, 5¾ miles. Weight of projectile, 2,370 pounds.
Powder charge, 576 pounds.

RADIUS OF ACTION OF SIXTEEN-INCH GUN.

## ARMIES OF THE LEADING POWERS.

Information on the above points concerning the Armies of Leading Powers is given in the following table.

| Nation. | System. | Peace Footing. | †War Footing. | Guns (Approximate Number). | Term of Service or Liability. Years.* | Total. |
|---|---|---|---|---|---|---|
| Austria | Compulsory Service | 390,000 | 2,580,000 | 2,464 | 3 A + 7 R + 2 L‡ + 10 L‖ | 22 |
| Belgium | Conscription and Voluntary | 49,664 | 143,000 | 204 | 8 A + 5 R. | 13 |
| Bulgaria | Compulsory Service | 43,000 | 221,000 | 462 | 2 or 3 A + 8 or 6 R + 7 L‡ + 8 or 9 L‖ | 25 |
| China | Enlistment | About 220,000 trained men. | | | ? | — |
| Denmark | Compulsory Service | 13,750 | 61,580 | 96 | ½ or 1½ A + 7½ or 6¾ R + 8 L‡ | 16 |
| France | Compulsory Service | 598,000 | 3,500,000 | 5,000 | 3 A + 10 R + 6 L‡ + 6 L‖ | 25 |
| Great Britain | Voluntary | 274,894 | ‡355,000 | 1,194 | 7 or 8 A + 5 or 4 R, 3A + 9 R. | 12 |
| India | Voluntary | 208,704 | 222,000 | 336 | From 3 years upward for natives. | — |
| Germany | Compulsory Service | 620,918 | 4,000,000 | 5,000 | 2 or 3 A + 4 R + 5 L‡ + 16 L‖ | 28 |
| Greece | Compulsory Service | 22,104 | 82,000 | 120 | 2 A + 8 R + 8 L‡ + 10 L‖ | 28 |
| Holland | Conscription and Voluntary | 27,366 | 68,000 | 120 | 1 A + 1 R + 3 L‡ + 10 L‖ | 30 |
| Italy | Compulsory Service | 261,000 | 3,330,000 | 1,726 | 2 to 5 A + 7 or 4 R + 10 L‡ | 19 |
| Japan | Conscription | 143,649 | §1,000,000 | 1,200 | 3 A + 4 R + 5 L‡ + 11 L‖ | 23 |
| Mexico | Conscription and Voluntary | 34,500 | 786,000 | 96 | | 30 |
| Norway | Conscription and Voluntary | 18,500 | 80,000 | 66 | 50 days A + 6 R + 6 L‡ + 4 L‖ | 16 |
| Roumania | Compulsory Service | 63,280 | 173,948 | 366 | 3 A + 6 R + 5 L‡ + 4 L‖ | 18 |
| Russia | Compulsory Service | 1,100,000 | §4,600,000 | 5,000 | 4 A + 13 R + 5 L‡ | 22 |
| Spain | Conscription | 80,000 | 500,000 | 408 | 3 A + 3 R + 6 L‡ | 12 |
| Sweden | Conscription and Voluntary | 42,000 | 570,000 | 240 | 68 days or 3 years A + 8 R + 4 L‡ + 8 L‖ | 20 |
| Switzerland | Compulsory Service | 20,122 | 526,105 | 450 | ½ A + 11½ R + 12 L‡ + 6 L‖ | 30 |
| Turkey | Compulsory Service | 216,530 | 1,530,700 | 1,530 | 4 A + 2 R + 8 L‡ + 6 L‖ | 20 |
| United States | Voluntary | 75,000 | 100,000 | 504 | 3 A. | 3 |

* A = Active Army. R = Reserve. L‡ = Landwehr, or Territorial Army. L‖ = Landsturm, or Territorial Reserves.

† The war strength of the various armies can only be given in round numbers as official figures are not published.

‡ Estimates of 1904–5. This total includes the British forces in this country, India, and the Colonies (excluding colored men). Does not include volunteers, militia, etc., at home.

§ Subject to modification by very severe losses.

—*Daily Mail Year Book*, 1905.

## FOREIGN ARMIES.

The latest particulars relating to the military power of the countries of Europe, Abyssinia, China, Egypt, Japan, Mexico, etc., from Hazell's Annual for 1904, will be found below.

### ABYSSINIA.

The organization is feudal in character, and the constitution is by provinces, each governor or Ras having a standing force as garrison and at call in case of war, and a considerable number of retainers not embodied. The garrison forces united constitute the new army of Menelik, and are estimated at 70,000 men. The central control is weak, and there are no organized divisions into the three arms, as in Europe; but the forces are readily grouped, the mounted men forming an irregular cavalry, and have great mobility. Practically every man has a sword and a rifle, but the firearms are extraordinarily varied, and the mounted troops also carry a javelin or spear. They do not exceed 5,000 altogether. The guns are mostly adapted for mountain work, there being about 50 modern and 30 old ones. The unembodied retainers, who may be likened to a militia, number about 140,000 men.

### ARGENTINA.

The army is sanctioned by an annual vote, as in Great Britain. The standing force and reserve consist of 120,000 men (18 battalions of Infantry, 12 regiments of cavalry, 8 of artillery, and 4 battalions of engineers). Outside these are the National and Territorial Guard, which have little training. Compulsory military service (25 years in all) was adopted in 1901, and it is believed that 500,000 men could be mobilized in case of war.

### AUSTRIA-HUNGARY.

The active army of the Dual Monarchy is an organization common to both kingdoms, and has its Ersatz, or supplementary Reserve, with local forces for Bosnia and Herzegovina attached. There are fifteen army corps, and certain troops in the military districts of Zara in Dalmatia. In addition are the Austrian Landwehr and Landsturm and the Hungarian (or Transleithan) Landwehr and Landsturm, known as the Honved.

During 1903 the army question rose to great prominence between the national parties in Austria and Hungary, and certain concessions were made to the latter in regard to the language of command, regimental colors, and other matters, but these do not affect the unity of the army.

The fifteen army corps comprise 5 cavalry divisions and 31 infantry divisions of the active army, and on mobilization a Landwehr division would be attached to each. There are 466 battalions of infantry (102 regiments of the line, 4 of Tyrolese rifles and 4 Bosnian, and 26 battalions regular rifles. The cavalry on a peace footing comprises 252 squadrons (15 regiments of Dragoons, 11 of Uhlans, and 16 of Hussars), and the artillery 251 batteries, exclusive of 18 battalions of fortress artillery and 15 of pioneers. The field artillery is formed in 14 brigades, and a group of 3 mountain batteries in the Tyrol. On a peace footing there are 224 field batteries, 16 horse batteries, 11 mountain batteries, 56 ammunition columns (in skeleton), and 56 depots. The war strength would give a total of 328 batteries (exclusive of fortress units), with a total of 2,464 guns. The Austrian and Hungarian cavalry have won the admiration of European soldiers, and the Empire unquestionably possesses a thoroughly practical mounted arm fit for service at a moment's notice.

The following table shows the total strength of the forces in 1903; but it is believed that by embodying all classes of the Landsturm the dual monarchy could put 3,000,000 men in the field.

| Forces. | Peace. | War. |
|---|---|---|
| Field Army | 266,000 | 687,000 |
| Landwehr and Honved | 51,000 | 237,000 |
| Reserve troops | 6,000 | 192,000 |
| Fortress troops | 7,000 | 31,000 |
| Transport Staff, etc | 16,000 | ..... |
| Landsturm | ..... | 393,000 |
| | 346,000 | 1,540,000 |

The Honved (national Hungarian army) is subject in war time only to the commander-in-chief, and in peace time only to the Royal Hungarian jurisdiction.

### BELGIUM.

The Belgian army was recently reorganized as the outcome of a popular agitation, leading to the appointment of a mixed commission which prepared a scheme. The main feature was the adoption of volunteer enlistment, with the purpose of bringing about a progressive decrease in the annular levy by subscription. Special advantages were offered, but the result has been very disappointing.

The establishment on Oct. 1st, 1903, when the recruits were embodied, was 42,000 men, but there was a deficiency of 7,000, owing to substitutes not having been found for men who had been absolved from service. The regiments were in some places so weak that training was impossible. The nominal liability is eight years with the colors and five in the reserve, and the recruit contingent is 13,300, the volunteers being in addition.

The composition is as follows: Cavalry—2 regiments of chasseurs, 2 of guides, and 4 of lancers. Each regiment consists of 4 squadrons active and 1 reserve. To the above have to be added the gendarmerie (over 1,700

RUSSIA Peace, 1,100,000 War, 4,600,000
TURKEY Peace, 701,000 War, 1,400,000
GERMANY Peace, 606,000 War, 3,000,000
FRANCE Peace, 598,000 War, 2,500,000
AUSTRIA-HUNGARY Peace, 493,000 War, 2,580,000
ITALY Peace, 262,000 War, 3,357,000
GREAT BRITAIN Peace, 222,000 War, 972,000
JAPAN Peace 168,000 War, 632,000
SPAIN Peace, 119,000 War, 214,000
UNITED STATES Peace, 60,000 War, 177,000

PEACE AND WAR FOOTING OF THE ARMIES OF THE WORLD.

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men). Artillery—4 field and 4 fortress regiments (in all 204 guns). Engineers—1 regiment of 3 battalions, a reserve battalion, and 5 special technical companies. Infantry—14 regiments of the line, of 4 battalions of 4 companies each, 3 active and 1 reserve battalion; 1 regiment of grenadiers, similarly organized; 1 regiment of carbineers of 6 battalions (4 active and 2 reserve), and 3 regiments of *chasseurs-à-pied*.

The Civic or National Guard is under the Minister of the Interior in peace time, and numbers approximately 45,000 men reckoned as "active," and 100,000 "non-active." The effect of the new law cannot yet be estimated fully.

BRAZIL.

Gradual progress is being made in the reorganization of the army, but much remains yet to be done. The strength and organization, given in the official *Revista Militar*, is as follows: staff, 28; engineer corps, 66; general staff corps, 124; medical staff, 163; artillery staff, 62; 6 regiments of artillery, 2,562; 6 battalions of artillery, 2,100; 2 battalions of engineers, 862; 14 cavalry regiments, 6,020; 1 transport corps, 292; 40 infantry battalions, 17,840; total, 30,119. The troops are divided into seven military districts, the most important being Rio Grande do Sul (11,226 men).

BULGARIA.

Military service is popular, and the peasantry have a great deal of excellent military spirit. The officer is also efficient, and the Government has taken very great care in selection and training, the Russian army being the pattern.

The forces are divided into three categories: the regular army, the reserve and the militia, and all Bulgarians are liable for personal service, with few exceptions, from the age of 20 to 45, substitution not being permitted. The country is divided into six divisional districts, and the annual contingent is about 18,000 men.

The peace strength is: infantry, 1,300 officers and 28,550 men; cavalry, 200 officers and 3,850 men; field artillery, 280 officers and 5,020 men; mountain artillery, 45 officers and 900 men; fortress artillery, 65 officers and 950 men; engineers, 18 officers and 1,900 men; transport, 20 officers and 160 men: total, 1900 officers and 41,330 men.

The total war strength is 3,810 officers, 202,500 men, and 29,200 horses. In addition Bulgaria can count upon at least 20,000 *Komitajis*, a force of semi-trained and experienced guerillas. The infantry arm is the 8 mm. Mannlicher rifle.

CHILE.

The army does not exceed 6,000 men, in accordance with the law of Feb. 2d, 1892, and the formations are: 7 regiments of infantry, 4 of cavalry, 3 of artillery, and a corps of engineers. The National Guard numbers over 50,000 men.

CHINA.

The Chinese army came under close observation during the Boxer Rebellion, and, although in many ways it gave proof of want of organization, it was recognized that in armament, training, and the things that go to make up the efficiency of the army, remarkable progress had been made. General Frey who commanded the French forces in China, says it is a mistake to hold that the Chinese Government has any repugnance to the creation of military forces. The Emperor is said to have issued an order extolling military discipline and disavowing any purpose of disarmament, and training is going on under Japanese officers. The Black Flags are now a force of real value.

It was never easy to ascertain facts concerning the Chinese forces. They may be divided into the old armies, comprising the Imperial or Banner troops; the new armies, composed of troops of comparatively recent formation (since the war with Japan); and the Mongolian and Thibetan Militias, which in peace time only exist on paper.

The *elite* of the old armies is composed of the Shen-Che-Ying or Black Flag troops, and the Pa-Ki or Eight-Banner men. The former are said to number 50,000 men with the colors. Next in importance to the Black Flags come the Banner men of the army of Manchuria, composed of soldier-like troops, but some of them still armed with bows and arrows, or with the old jingal. The Banner men have been estimated at something like 300,000. Service with the Manchus is hereditary, and the Banner men are still the chief support of the Ta-tsing dynasty. The army of Manchuria must be profoundly affected by the Russian occupation of the country. The Luh-Ying or Green Flags, with a paper strength of 500,000 men, scattered through the empire, possess little military value, and as now organized can be of no real service.

The new armies consist of enrolled or conscript armies (irregulars), strength about 100,000 men, raised at the initiative of the viceroys and governors of provinces in the event of revolution or of war with Europeans; and the active armies, dressed like Europeans, and formed of the best men drawn from the Green Flag Army—strength 210,000 men. These troops occupy important strategic points, and are under the orders of the provincial authorities. The best of them are in the province of Chi-Li, where the army was reorganized by Yun-Hu and Lu-Chang.

Before the Boxer troubles, Major A. E. J. Marshall, of the British Army, one of the best authorities, summed up the number and disposition of the whole available force of China thus:

FIGHTING TROOPS.

| | |
|---|---|
| Manchurian Field Force | 50,000 |
| Manchurian Irregulars | 50,000 |
| Fighting Braves | 125,000 |
| Chien-Chun, or Disciplined Troops | 10,000 |
| | 205,000 |

RESERVES UNDER ARMS.

| | |
|---|---|
| Peking Field Force | 13,000 |
| Banner Troops in Peking | 75,000 |
| Banner Troops in Provinces | 95,000 |
| Luh-Ying, or Green Flags | 506,000 |
| | 689,000 |

DENMARK.

Service is obligatory on all able-bodied men who have reached the age of 22. Terms of service, eight years with the colors and eight in the extra reserve. A reorganization of the Danish army was introduced in 1894, and the late War Minister, General Bahnson, calculated that the contingent brought under training 7,947 men yearly. The service in the various branches of the army is 16 years; but, reckoning 14 years only, and allowing for waste, the General concludes that by the year 1910 Denmark will be able to mobilize 83,000 men, of whom 58,500 will be infantry, 5,000 cavalry, 6,800 field artillery, and 8,600 fortress artillery. The really effective force would be about 70,000. At present the peace strength (31 battalions, 16 squadrons, and 12 field batteries, with fortress artillery and engineers) is 13,750, increased on mobilization to 50,000.

EGYPT.

The Egyptian army, under strong leadership and the command of British officers, has shown excellent quality. All the inhabitants are liable for service—six years in the army, five in the police, and four in the reserve, and there are always about 150,000 young men on the rolls for conscription; but the burden is very light, and the men are all selected. The cavalry are recruited from the fellaheen of the Delta. The infantry battalions are drawn mostly from the fellaheen, but several are Soudanese blacks. The first are filled by conscription, and have about 800 men each, mostly fellaheen, in 6 companies. The interior economy and drill of the recruits is excellent, and the musketry good. The arm is the Martini-Henry. In the Soudanese battalions the service is voluntary. This force was raised largely from the Khalifa's black riflemen, but men from Lower Egypt have been enlisted.

The artillery is the force that shows most markedly the impress of the European training. The horse battery has Syrian horses and light Krupp guns. The field batteries have Krupp mountain guns carried by mules, with a second line of camels. There is also a battalion of garrison artillery, organized as in our service.

The Egyptian Army has been reduced recently, owing to the smaller demand for its services, and some of the Soudanese have been disbanded. About 8,000 men have left the colors. The command is vested in Major-Gen. Sir Reginald Wingate, with the title of Sirdar.

The British forces in Egypt are 4 regiments of infantry, 1 of cavalry, 2 field batteries, and detachments of fortress artillery and engineers, with a strength of 5,482 in 1903-4.

FRANCE.

The French army is administered by the War Departments, or Ministry of War, with General Andre at its head, assisted by a military cabinet and the chiefs of various bureaux. The chief of the general staff of the army is responsible to the Minister, and controls the directorates of infantry, cavalry, engineers, artillery, finance, etc.

In 1904 the effectives with the colors are estimated as follows: 29,000 officers, 520,831 men, and 142,474 horses, being a diminution of 76 officers and 6,228 men as compared with 1903. The establishment will be 515,600 men. The smaller number embodied results from the contingent being less than in previous years.

The Active Army is constituted as follows: 652 battalions of infantry, 30 battalions of chasseurs, 10 foreign, 20 zouaves, 24 Algerian tirailleurs, 1 Saharan tirailleurs, and 5 African light infantry: total, 742 battalions, 13,370 officers, 24,432 non-commissioned officers, 342,068 men: total, 379,890. The cavalry form 31 regiments of dragoons, 21 of chasseurs, 14 of hussars, 13 of cuirassiers, 6 of chasseurs d'Afrique (all of 5 squadrons), and 4 of Spahis, variously constituted, numbering in all 448 squadrons, 3,891 officers, 4,552 non-commissioned officers, 64,756 men: total, 73,199, and 61,028 horses. The organization of the artillery is as follows: field batteries, 434; horse batteries, 52; mountain batteries, 22; foot (or fortress) batteries, 112: in all, 620; officers and men, 77,213. The engineers (including railway troops) number 7 regiments, 20 battalions and 3 railway companies) with telegraphists, ballooning troops, etc., officers and men, 13,426; and the military train has 20 squadrons (comprising 72 companies), officers and men, 8,167.

In relation to the organization given above, it must be noted that owing to the class embodied in November, 1903, consisting only of 196,000 men, as compared with 238,000 enrolled in the previous year, it has been decided to abolish 68 companies of the fourth battalions of regiments which had not been completely formed. These fourth battalions were raised in 1897, and could only be properly organized in 93 out of 145 subdivisional regiments. In consequence of the latest abolition there remain only 65 fourth battal-

ions, not including the 18 belonging to district regiments, which are all up to strength.

The forces are organized in 20 army corps, exclusive of the Paris garrison; their headquarters being at Lille, Amiens, Rouen, Le Mans, Orleans, Chalons-sur-Marne, Besancon, Bourges, Tours, Rennes, Nantes, Limoges Clermont-Ferrand, Lyons, Marseilles, Montpelier, Toulouse, Bordeaux, Algiers, Nancy.

A proposal is before the French parliament for reducing the period of service with the colors to two years, and it is the general opinion that the measure will become law. It is proposed to embody a considerable number of re-enlisted men in order to make good the deficiency that will arise.

Under the existing rules every Frenchman should serve three years in the active army, ten years in the reserve of the active army, six years in the territorial army and six years in the reserve of the territorial army. For administration, training and mobilization, the units of the territorial army, as well as the active reserve, are attached to the corresponding units of the active army. The reserve troops are: 145 infantry regiments, 30 chasseur battalions, 38 cavalry regiments formed with the line and light cavalry regiments of the corps cavalry brigades, 41 other squadrons formed with the divisional cavalry regiments, and 216 batteries of field artillery. 12 to each artillery brigade. The territorial forces are 145 battalions of infantry, 7 of rifles, 10 of zouaves, 40 battery groups of field artillery and 16 of foot artillery, 21 battalions of engineers, and 19 squadrons of train. There are special dispositions in regard to some army corps, and a large number of battalions and independent companies are employed in the customs and forest service. In regard to the localization of the troops, it should be noted that a large force is quartered on the German frontier, where the 6th corps has been divided into two, and a new corps thus created. The reserve of the active army includes about 1,320,000 men, and the Territorial Army and its reserve about 2,270,000.

It has been estimated that the French army, with its various reserve and territorial forces, includes 3,500,000 trained men on a war footing, and that 4,000,000 untrained men might be embodied.

The French colonial army has been brought under the authority of the Ministry of War, and comprises 6 brigades of infantry, 12 battalions of field artillery, 6 mountain batteries, and 12 garrison batteries.

In Madagascar and Indo-China are 10 battalions of French and 18 battalions of native infantry, and 4 field, 6 mountain, and 5 garrison batteries; in West Africa, 2 French and 8 native battalions, 2 mountain and 3 garrison batteries; in Martinique, 7 French and 10 native battalions, and 2 field, 3 mountain and 3 garrison batteries; and in various other stations some 6 French and 3 native battalions, with 1 mountain and 5 garrison batteries. For some time past France has been strengthening her military forces in French Indo-China, where there are now at disposal 3 brigades of troops in actual existence, with a reserve brigade. The approximate strength of the native forces in the colony is as follows:

| | |
|---|---|
| French infantry, 3 regiments. . . . | 3,000 men |
| Foreign Legion, 4 battalions . . . . | 3,000 " |
| Native infantry, 6 regiments . . . . | 18,000 " |
| "Milice indigene" (native constabulary). . . . . | 10,000 " |
| Total of infantry . . . . . | 34,000 " |

GERMANY.

The administration and command of the army is exercised through the great general staff, a most powerful and efficient organization, by which the work of the army is prepared for in peace and molded in war. It is at once a close and yet flexible organization, which permeates the whole structure of the army, consisting for Prussia of about 200 officers. Nearly 100 of these are detached on service with the staffs of corps or divisions, while the remainder constitute the great general staff in Berlin. There is constant interchange between regimental work and staff work, and between the latter locally and with the headquarters staff in Berlin. Scarcely any regimental officer rises high in his corps without having been called to staff service; so that the ideas of the staff are based upon practical experience, and react upon the whole army, to which they come as a kind of tradition of duty and policy, sharpening and directing the life and work of the army. Recently the inspection of the cavalry and artillery has been improved.

The forces are organized in 22 army corps, and comprise 625 battalions of infantry, 482 squadrons of cavalry, 754 batteries of artillery, 38 battalions of foot artillery, 25 battalions of pioneers, 11 battalions of Army Service troops, and 23 battalions of train, with a peace strength of 495,500 rank and file, exclusive of one-year volunteers. The establishment is given as 620,918. The contingent annually embodied approaches 275,000 men. The service in the standing army is of six years, two of these with the colors in the infantry and three in the cavalry and horse artillery, and the rest in the reserve. After quitting the reserve of the Active Army the soldier passes five years in the Landwehr and seven in its reserve. The recruiting service of the Guard, consisting of the tallest and finest-looking men, is carried out by a committee, consisting of officers specially nominated for the purpose. Under the system of recruiting there are always more men than are necessary to keep up the army strength, the surplus constituting the Ersatz Reserve.

The strength upon mobilization is estimated at 2,310,000 infantry, 151,000 cavalry, 329,000 artillery, 78,000 technical troops, 168,000 other formations, making a total of 3,036,000 trained men.

GREAT BRITAIN.

Under the new system, the British Army has been organized in Army Corps. It was designed to form six of these, but up to the present time only four have been constituted.

The organization of a British Army Corps is as follows:—Infantry, 25 battalions; artillery, 150 guns—viz., 18 batteries of field artillery, two batteries horse artillery, three batteries of howitzers, and three batteries of 4.7-in. guns. These last batteries have only four guns each, all the others six. The cavalry of an Army Corps includes two regiments, one immediately attached to the Divisions, the other to the Special Corps troops, and, in addition, for purposes of peace organization, there is a cavalry brigade of three regiments in each Army Corps command.

The local organization of the Army Corps districts does not supersede that of the older regimental districts, of which there are 67, each under the command of a colonel. The regimental district is the recruiting ground of a territorial regiment, with which are linked, as junior battalions, the militia and volunteer corps within the area; and the reserve men are pensioners of their respective territorial regiments. The Royal Artillery, through 9 recruiting areas, and the Royal Engineers, through the commanding Royal Engineer in each district, have also a territorial organization; but this is not the case with the Cavalry, which has special recruiters or staff officers located in various districts. In theory, one battalion of each Infantry regiment is at home, as a feeder for the other abroad; but in practice this system has never been uniformly maintained, and was completely dislocated by the war in South Africa. The Army Service and several departmental corps are part of the organization.

The following is the organization of the Regular Army according to the units of each arm of the service. The strength is given below:

| | | |
|---|---|---|
| Household Cavalry .... | Regiments | 3 |
| Cavalry of the Line. . . . | do | 28 |
| Horse Artillery. . . . . | Batteries | 30 |
| Field Artillery. . . . . | do | 158 |
| Mountain Artillery . . . . | do | 11 |
| Garrison Artillery. . . . . | Companies | 111 |
| Royal Engineers . . . . . | do | 100½ |
| Foot Guards. . . . . | Battalions | 10 |
| Infantry of the Line. . . . | do | 161 |
| Army Service Corps. . . . | Companies | 72 |
| R. A. Medical Corps . . . | do | 56 |
| Army Ordnance Corps . | do | 24 |

In addition to these are Colonial Corps and Indian Infantry in Egypt, Barbados, Jamaica, Bermuda, Malta, West Africa, Mauritius, Ceylon, China, and Hong Kong, the Straits Settlements, etc.

The Army Reserve is a vital element in the Army organization, the Reserve men being liable by the terms of their agreement to general service with the arms in which they were enrolled with the colors. The Reserve was profoundly affected by the war in South Africa, and the general mobilization of the force showed that the force could be relied upon. Reservists, who have served their period with the colors, and who are of the best soldiering age, and available for service if required, are an excellent set of men. The reserve men are pensioners of the respective territorial regiments, and look to the officer commanding the district as their commanding officer.

The establishment as at present authorized is 80,000. Subsequently to the war men have been drafted in large numbers to the Reserve, and the numbers increased by 18,288 between Jan. 1st and April 1st, 1903. The Reserve comprises Sections A, B, C and D, the B section being the most important, comprising all who have enlisted for short service and have discharged their active duties. The following was the strength of the several sections on Jan. 1st, 1903: A, 328; B, 28,759; C, 697; D, 3081: total, 32,865.

A new scheme for the enlistment of railway employés into the Reserve, through the agency of the Engineer and Railway Volunteer Staff Corps, and under the direct supervision of the commandant of that corps, has borne fruit, and bids fair to be a success.

A further reserve force connected with each regimental district is the Militia Reserve, to be embodied with the Militia upon mobilization.

MILITIA.

During the Boer War the Militia, though it was kept in the background, accomplished what no other branch of the army could do. Without external aid it provided a large number of organized and completed battalions for home, foreign, and active service, thus maintaining its old traditions, and demonstrating its high value among the military forces of the Crown. The service upon the lines of communication was most arduous. The Militia is a force of very old standing, the purpose of which is to provide a body of trained men, available in case of need or of imminent national danger, to supplement, support, or relieve the regular army at home and on the Mediterranean stations. There are in all 124 Infantry battalions attached to the Line regiments, 32 corps of Garrison Artillery, 3 Field Batteries, 2 fortress corps of Engineers, 10 divisions of Submarine Miners, and 2 companies of the Medical Staff Corps. The Malta regiment, some colonial corps, and 8 Channel Island regiments are in addition. It has often acted as a feeder to the Regular Army, and, under the territorial system, this has come to be regarded as its chief function. A very large number of militia recruits are every year transferred to the line—as many, indeed, as

one-third of the whole number enlisted—and the force is a channel through which many commissions are annually gained in the regular Army. This system is to be continued. Great dissatisfaction was felt owing to the retention of Militia battalions for so long a period in South Africa, whereby a real hardship was inflicted upon officers and men, and the feeling is general in the force that it is neglected.

The Militia recruit is enlisted for six years, and may re-engage if under 45 years of age for a further period of four years. Recruits are liable, at any time after enlistment, to be assembled for preliminary drill for such period, not exceeding six months, as may be directed, from time to time by the Secretary of State for War. Brigades and regiments are called out annually for 27 days' training, which may be extended to 56 days if deemed expedient.

The Lord-Lieutenant of a county recommends to the consideration of the Secretary of State for War, for submission to His Majesty, the names of candidates for first appointment to Commissions, commanding officers being directed to assist him in the selection if called upon. For subaltern officers in the Militia, candidates must be seventeen years of age or upwards. The appointment of officers as captains and field officers is recommended by the Militia commanding officer direct.

The New Militia Reserve, to be formed as a "Reserve Division of the Militia," was authorized by a Royal Warrant (Feb. 4th, 1903), under the Militia and Yeomanry act, 1892, and has an establishment of 50,000. It is intended to raise the force in round numbers from 100,000 to 150,000, and, in order to stimulate recruiting, men joining from the garrison Regiment receive $30 annually, and other men $22.50, with quarters and rations during training. The arrangements for musketry training are to be increased. Men of the Reserve Division are liable to serve with the Militia whenever that force is embodied by proclamation.

The services of the Imperial Yeomanry in South Africa, in the organizations of which the old Yeomanry Cavalry played a very large part (although in the actual composition of the force the regular yeomen formed only about one-fifth of the total strength), caused the military authorities to reorganize the force. An Army Order of April 17th, 1901, provided that it should, in future, be entitled the "Imperial Yeomanry," and that the brigade organization should be abolished, and the force be organized in regiments of four squadrons, with a regimental staff and a machine-gun section. The order included rules as to efficiency, drills, and pay. During the period of training, and under conditions laid down, the daily pay, including ration allowance, varies from $1.35 in the case of a private to $2.38 in the case of a regimental sergeant-major, with 1s. additional when a non-commissioned officer acts as quartermaster. It was also announced that after Oct. 31st, 1901, all corps of Volunteer light horse and Volunteer companies of mounted infantry would be disbanded or merged into squadrons of the Imperial Yeomanry. The number of regiments so far constituted is 52. A Committee on the organization of arms and equipment of the Yeomanry Force reported upon the subject in January, 1901, and it was decided, under the new Army scheme, to provide the Yeomanry with rifles, to give them extra pay as indicated above, with horse allowance of $25 and to raise the force to 35,000 as Imperial Yeomanry intended to furnish mounted troops for home defense, while Colonial Yeomanry are to be affiliated for Imperial services. There is a school for instruction for officers of Imperial Yeomanry, with a lieutenant-colonel as commandant and a staff of 66.

### THE VOLUNTEERS

Volunteer corps are raised under the Volunteer Act 1863 (26 & 27 Vict., c. 65). They are subject to the provisions of that Act and any Acts amending it, and likewise to all regulations made with regard to Volunteer corps. The Volunteer (Military Service) Act of '96 provides that whenever an order for the embodiment of the Militia is in force, any member of a Volunteer corps may offer himself for actual military service, and if the services of such members of any corps are sufficient to enable them to be separately organized are accepted, then those members may be called out either as a corps or as part of a corps. Under the Volunteers Act 1900 new regulations were made as follows:—I. A member of a Volunteer corps may contract to come out for actual military service in Great Britain whenever summoned, and to serve for a period not exceeding one month in the absence of a Royal Proclamation calling out the Volunteers generally. II. A member of a Volunteer corps may contract to proceed upon active service to any part of the world in a unit or company formed of Volunteers, on special conditions as defined by the terms of his contract.

The Volunteers, like the Militia, form junior battalions attached to the line regiments in their respective districts. Their own organization as a cohesive and independent fighting force is still imperfect, and the new Army scheme proposes a much higher level of efficiency and an improved organization.

Like the Militia, the Volunteers hold a considerable place in the new Army scheme of 1901-2, and now enter into the composition of the fourth Army Corps. The force numbers 223 battalions, and of these 27 are included in the Army Corps scheme. The Volunteers are to be specially trained for its work with the Army Corps and for positions round London, while increased drill and rifle shooting are to contribute to efficiency. The Government programme for reorganizing the Army, presented in February, 1900, included the providing for extended training in camp during the

summer and for the supply of regimental transport and caused very considerable difficulty and dissatisfaction. The view of the War Office is that if Volunteers cannot conform to the new regulations, they must face some reduction of numbers, since it would be more to the purpose of the Government to get a smaller body of efficient men upon which it could rely. A controversy has raged round this point, and it was contended by many Volunteers that the most zealous among them could not conform to the requirements. The returns of Nov. 1st, 1902, showed a considerable decline in numbers as compared with the previous year (268,550 as compared with 288,476), and a decrease in the percentage of efficients to the enrolled strength (95.49 as compared with 97.43), and in numbers present at inspections (77.48 as compared with 83.93). The decline has been continued. Particulars are given below.

EFFECTIVES AND DISTRIBUTION.

Establishment and Strength of Army, Army Reserve, Militia, Imperial Yeomanry, and Volunteers on Jan. 1st, 1903 (all ranks).

| Forces. | Normal Establishment | Actual Strength | Wanting to complete |
|---|---|---|---|
| Army, Regular: Forces, Regimental Establishments | 284,378 | *324,653 | — |
| General and Departmental Staff and Miscellaneous Establishments | 2,400 | 2,400 | — |
| Army Reserves, Class I | 80,000 | 32,865 | 47,135 |
| Militia | 131,737 | 108,568 | 23,169 |
| Militia Reserve (New) | 50,000 | † | 50,000 |
| Channel Islands and Colonial Militia | 6,002 | 5,068 | 934 |
| Imperial Yeom'nry at Home | 35,164 | 22,942 | 12,222 |
| Volunteers | 346,450 | 250,990 | 95,460 |
| Bermuda Rifle Volunteers | 319 | 233 | 86 |
| General total | 936,450 | 747,719 | 188,731 |

ACTUAL STRENGTH OF THE REGULAR ARMY BY ARMS.

| | |
|---|---|
| Household Cavalry | 1,490 |
| Cavalry of the Line | 29,297 |
| Imperial Yeomanry | 1,610 |
| Royal Horse Artillery and Royal Field Artillery | 34,959 |
| Royal Garrison Artillery | 23,174 |
| Royal Engineers | 13,757 |
| Foot Guards | 9,966 |
| Infantry of the Line | 176,580 |
| Colonial Corps and Indian Infantry borrowed for garrison and expeditionary purposes | 15,503 |
| Army Service Corps | 8,443 |
| Royal Army Medical Corps | 6,020 |
| Army Ordnance Corps | 2,638 |
| Army Pay Corps | 853 |
| Army Post Office Corps | 362 |

*Parliament in 1902 sanctioned 200,300 excess numbers.

†Not formed on Jan. 1st, 1903.

It appears from the General Annual Return of the Army that in the year ending Dec. 31st, 1902, 51,677 recruits joined (2,317 for long service, 49,360 for short service), as compared with 47,039 in 1901.

THE STRENGTH OF THE ARMY RESERVE

from 1898 to 1903 has been as follows:—1898, 82,063; 1899, 78,839; 1900, 24,388; 1901, 5,434; 1902, 2,573; 1903, 32,865. The reduced numbers since 1901 have been due to Reservists being embodied with the Regulars for the war. The establishment is 80,000, and on April 1st, 1903, the strength had increased to 51,153, leaving 28,847 wanting to complete the establishment. It is impossible to give satisfactory details, there being a large number of men on gratuity furlough, eventually to be transferred to the Reserve.

CHANGES IN ESTABLISHMENT AND EFFECTIVE OF THE MILITIA

during the last seven years, exclusive of the permanent staff:

| Date. | Effective strength | Establishment | Wanting to complete |
|---|---|---|---|
| 1st Jan., 1896 | 108,350 | 126,723 | 18,373 |
| " 1897 | 107,878 | 126,609 | 18,731 |
| " 1898 | 105,531 | 125,435 | 19,904 |
| " 1899 | 103,647 | 124,481 | 20,834 |
| " 1900 | 98,130 | 123,137 | 25,007 |
| " 1901 | 92,741 | 124,252 | 31,511 |
| " 1902 | 102,845 | 123,993 | 21,148 |
| " 1903 | 131,737 | 108,568 | 23,160 |

The figures from 1900 onwards do not include Militia Reservists called out on permanent service with the Line. Recruiting in 1902 showed a material increase—41,486, as compared with 37,644 in the previous year. Returns are not available for 1903.

The new Militia Reserve has an established strength of 50,000. Its formation began in 1903, but particulars are not available of the effective attained.

ENROLLED STRENGTH OF THE IMPERIAL YEOMANRY

in 1902, 21,840, and the number present at the inspection 19,570. The establishment being 35,164, the number wanting to complete was 13,324. On Jan. 1st, 1903, the enrolled strength had increased to 22,945, the recruits numbering 8,845, and the net increase during the year 1902 having been 5,546. These figures are exclusive of Imperial Yeomanry in South Africa (2,449 raised in 1902), who are included in the strength of the Regular Army, and certain regiments not yet formed are included in the establishment. On Jan. 1st, 1903, the establishment of the recruits formed was 30,992, and the strength 22,942.

STRENGTH OF THE VOLUNTEERS.

The conditions affecting unfavorably the strength of the Volunteers have been given above. The establishment is 346,450, and the actual strength by the latest return (Jan. 1, 1903) 250,990, leaving 95,460 wanting to complete. The enrolled strength has been as follows since the establishment of the force:

| | | | | | |
|---|---|---|---|---|---|
| '60, | 119,146; | '61, | 161,239; | '62, | 157,818; |
| '63, | 162,935; | '64, | 170,544; | '65, | 178,484; |
| '66, | 181,565; | '67, | 187,864; | '68, | 199,194; |
| '69, | 195,287; | '70, | 193,893; | '71, | 169,608; |
| '72, | 178,279; | '73, | 171,937; | '74, | 175,387; |
| '75, | 181,080; | '76, | 185,501; | '77, | 193,026; |
| '78, | 203,213; | '79, | 206,265; | '80, | 206,537; |
| '81, | 208,308; | '82, | 207,336; | '83, | 209,365; |
| '84, | 215,015; | '85, | 224,012; | '86, | 226,752; |
| '87, | 228,038; | '88, | 226,469; | '89, | 224,021; |
| '90 | 221,048; | '91, | 222,046; | '92, | 225,423; |
| '93, | 227,741; | '94, | 231,328; | '95, | 231,704; |
| '96 | 236,059; | '97, | 231,796; | '98, | 230,678; |
| | | '99, | 229,854; | 1900, | 277,628; |

1901, 288,476; 1902, 268,550. The later return mentioned above (250,990) shows a further falling off of 17,560, and it is believed that the diminution has not ceased. The shortage of officers on Jan. 1st, 1903, was 1895.

GREECE.

Service is for two years with the colors and eight in the reserve, eight in the National Guard and ten in its reserve; the cavalry, however, spending ten years in the National Guard and eight in its reserve.

The Standing Army consists of ten infantry regiments, eight battalions of light infantry and rifles, three cavalry regiments, and three regiments of field artillery. The Gendarmerie consists of sixteen divisions, and the men are borne upon the strength of the line. The peace strength of the army is about 1880 officers and 25,000 men. As a matter of fact these numbers are never attained under ordinary circumstances, the number with the colors varying from 16,000 to 18,000. There are three general commands. The total war strength is 82,000 men and 114 guns. Including the territorial army, and its reserve, there are said to be some 160,000 men available, but the organization is very defective. The Evzonoi highlanders are by far the best troops.

ITALY.

The Italian army consists of the Active Army, the Mobile Militia, and the Territorial Militia. There are 12 army corps, each having 2 infantry divisions, except that in the Rome district, where are three. The organization of the permanent army comprises 96 regiments of line infantry (288 battalions), 12 regiments of bersaglieri (36 battalions) and 7 Alpine regiments (22 battalions). The strength varies considerably, the company having upon a peace strength a maximum of 100 and a minimum of 60, with a mean of 80, known as the *forza bilanciatia*. Large numbers of men are upon what is known as unlimited leave. There are 24 regiments of cavalry (144 squadrons), each squadron having a mean strength of 145 men and 124 horses. There are 24 regiments of field artillery, with 186 6-gun batteries, but in peace time the battery has only 4 guns. The army also comprises 1 regiment of horse artillery (6 batteries), 1 of mountain artillery (12 batteries), 1 brigade of mountain artillery, with 3 batteries in Venetia, 3 regiments of coast artillery and a brigade in Sardinia, 2 regiments of fortress artillery and 5 of engineers, comprising 60 companies of the various branches.

The total strength of the forces is given as follows:

| | Officers and Men. |
|---|---|
| With the colors | 248,111 |
| On unlimited leave | 486,290 |
| Mobile Militia | 320,170 |
| Territorial Militia | 2,275,631 |
| Total | 3,330,202 |

There are about 1,250 guns with the Regular Forces and 378 with the Mobile Militia.

JAPAN.

The military forces of Japan are the Permanent Army, with reserves and recruiting reserves, the Territorial Army, the National Militia and the militia of certain of the islands. The Permanent Army is available for foreign service, the Territorial Army for home defense, and the militia for auxiliary operations in more distant parts of the country.

Service is personal and obligatory from the age of 17 to 40. The total actual period is 12 years and 4 months, of which 3 years are in the Regular Army, 4 years and 4 months in the Reserve, and 5 years in the Territorial Army. The recruiting reserve is drawn from the excess of the contingent, and the men, after passing their 7 years and 4 months in the Reserves, pass to the Militia.

The Emperor is supreme head of the army, and military affairs are directed through the War Minister and the Chief of the General Staff by the Superior War Council. In order to insure unity of action between the various branches of the navy, there is a council consisting of the War Minister, the Naval Minister, the chiefs of the General Staff and the Naval Staff and the Director-General of Military Training.

The following are details of the effective strength of the army on a war footing, not comprising the troops in the island of Formosa: Administrations and establishments, 1,000 officers, 2,900 men; Permanent Army, infantry, 156 battalions; cavalry, 55 squadrons with 9,000 horses; field artillery, 19 regiments of 6 batteries with 684 guns; fortress artillery, 20 battalions; engineers, 13 sapper battalions and 1 railway battalion; transport, 13 battalions: total, 203 battalions, 55 squadrons, 684 guns; or 7,500 officers, 193,790 men,

61,390 horses. Depot troops: 52 battalions, 17 squadrons, 26 companies, 19 batteries; or 1,000 officers, 34,600 men, 9,000 horses, 114 guns. Territorial Army: 130 battalions, 26 squadrons, 312 guns, 3,200 officers, 118,530 men, 11,860 horses. Militia: 35 officers, 1,180 men, 210 horses. Grand total, 386 battalions, 26 companies, 99 squadrons, 1,116 guns, 11,735 officers, 348,100 men and 84,460 horses. The total fully trained force, according to the *St. Petersburg Gazette*, is 509,960. The Military College and Academy train accomplished officers of great intelligence. They were pronounced by General Grant to be among the foremost of the kind in the world. The barracks and gymnasia are of the best type, and every care is paid to the physical development of the men.

MEXICO.

The Mexican army consists in peace time of 3,500 officers, 31,000 men, and 11,000 horses or mules. It was proposed to introduce personal or obligatory service, but the plan has been postponed, and the army is recruited by voluntary engagement of 3, 4 and 5 years, with special levies drawn by lot. The passage of the forces to a war footing has been defined by law, and provision is made for mobilizing the first and second reserve, including the rural and urban police, the national guard and other forces.

The following is the strength: Regular army, 2,700 officers, 61,000 men; reserves, 1,000 officers, 155,000 men; total, 3,700 officers, 186,000 men, with 32,000 horses and 12,000 mules.

MOROCCO.

The Sultan's forces comprise about 30,000 excellent men of all arms, under command for training of Kaid Sir Harry Maclean. The infantry arm is the Martini.

THE NETHERLANDS.

Holland has at present no standing army, but a cadre of officers and non-commissioned officers (establishment about 2,200) for training the forces embodied.

The Landwehr, which has replaced the old Schutterij, received its first contingent recently, and the country has been divided into 48 Landwehr districts. The corresponding battalions cannot, however, be formed before 1909. The Landwehr and Landsturm to which men are to be transferred will have a peace strength of about 20,000, and a volunteer establishment in time of war, the militia to be increased to 12,300, to be permanently embodied, with 5,200 more to be called up for short periods; and the reorganization is being proceeded with. The total armed strength is estimated at 69,000.

The army of the Dutch East Indies numbers about 35,000 officers and men, recruited voluntarily, one-half of the men natives, and a plan of mobilization for war has recently been adopted.

PORTUGAL

The army was reorganized on October 1, 1899. The peace footing is 62,427, including 33,420 militia. The infantry of the line are 18,000, the cavalry 3,032, the dragoons 1,804, the light troops 1,012, the field artillery 3,375 and the horse artillery 479. The total number of guns is 448. The war footing is 100,264 including 52,675 militia.

A new law was introduced in September, 1895, by which the service is three years with the colors, five with the first reserve and four with the second. There is in addition a colonial army of 9,000. The rules of exemption are most liberal, a sum of money paid to the Government being accepted as an equivalent.

ROUMANIA.

The armed forces of Roumania consist of the Regular Army, the Militia, and the Opoltchénie. In peace time there only exist cadres for the regular army, which is divided into permanent and territorial troops. The period of service for the permanent troops is three years, and for the territorial troops five years for the infantry and four for the calvary; but in this latter force the soldier at first only puts in three months of continuous service; he is then sent to his home and called up, in his turn, for one week each month.

The effective of the army in war is as follows: Infantry: 8 rifle battalions; 34 infantry regiments (102 battalions; altogether 2,250 officers, 126,000 men, and 4,700 horses). Cavalry: 6 *Roshiori* regiments (24 squadrons, forming an independent division); 11 *Caalrashi* regiments (44 squadrons); total, 530 officers, 13,200 men, 12,100 horses. Artillery: 12 regiments (75 batteries, 450 guns; 40 ammunition columns; 2 fortress artillery regiments); total, 930 officers, 26,900 men, 22,800 horses. Engineers: 12 sapper companies, 4 telegraph, 4 pontoon, and 4 railway companies: total, 140 officers, 6,200 men, 1,500 horses. Grand total, 2,850 officers, 169,800 men, and 41,400 horses. If to these are added the transport, auxiliary troops, 32 militia regiments, etc., the numbers will amount to 7,500 officers, 314,000 men, and 65,000 horses.

RUSSIA.

The huge Russian army makes continual progress, and its varied composition and little-known development make it very difficult to describe. It may be said to consist of several armies: the European, the Caucasian, the Turkestan, and the Amur force; the first of these organized like other European armies, and the constitution of the others varying in conformity with local requirements. Moreover, the strength of each varies according to the necessities of the situation, the troops being on the

ordinary peace footing, on the higher peace establishment as in the frontier districts, or on the war footing as in Asiatic Russia. There are 13 greater military districts, the Transcaspian district, and the territorial region of the Don Cossacks. There are 25 army corps in Europe and the Caucasus, 2 in Turkestan, and 2 in the Amur district.

The peace strength has been given as follows:

| | Europe and the Caucasus. | Asiatic Russia. |
|---|---|---|
| Infantry | 627,000 men. | 83,000 men. |
| Cavalry | 116,000 " | 14,000 " |
| Artillery | 138,000 " | 15,000 " |
| Engineers | 34,000 " | 8,000 " |
| Army services | 34,000 " | 5,000 " |
| Total | 949,000 " | 124,000 " |

Of these forces the active army numbers 731,000 in Europe and the Caucasus, and 87,000 in Asiatic Russia. Baron von Tettau, in a volume on the Russian Army (1902), gives the peace strength, including Cossacks and Frontier Guards, as 1,100,000.

It must be understood that in regard to the preceding estimate and in what follows concerning the distribution of the Russian forces, considerable doubt exists. The troops were moved secretly in view of the war with Japan, and very various statements have been made as to the force actually available in the Far East.

An Imperial order of November 12, 1903, gave instructions for the formation of 2 new brigades.

The Cossack forces have a special constitution. Every Cossack becomes liable to serve as soon as he has completed his eighteenth year. For the first three years, which are looked on as "preparatory," his service is, however, purely local; but for the next twelve years he is considered as belonging to the "front" category. This category consists of three bans, the first of which is formed of men actually serving, and the two others of men who have been granted unlimited leave. The last five years are spent in the Reserve category. There is, however, a still further category, for which no limit of age is fixed: this comprises all able-bodied Cossacks not otherwise classified. These have to supply and maintain their own horses, besides providing their own clothing and equipment. The peace effective of the Cossacks is stated to be 65,930, with 52,400 horses, but it is probable that not more than 54,000 are permanently with the colors. The war strength is given as 182,065, including 4,275 officers, and there are 173,150 horses. This gives a percentage of 13.2 to the male population liable to Cossack service.

In the Russian Empire considerably over a million men annually attain the age for joining the army. In 1902 the number liable to serve was 1,122,000, and 315,832 were embodied in the standing army. Seventy per cent. of the men so entered are illiterates. About 5,000 enlist annually as volunteers, and 16,000 join the Cossacks. The period of liability to personal service lasts from the twenty-first to the forty-third year of age. Those who join the standing army spend five years with the colors (four in the infantry), thirteen in the reserve, and the remainder in the Opoltchénie, or militia. In some instances, however, the War Minister has power to retain men for a longer period with the colors; whilst, on the other hand, this period is shortened by one, two, three, or four years for those possessing a superior education. The Opoltchénie, which has been developed from a simple militia into a first reserve formation, now embraces two different classes: (1) Men between 21 and 43 years of age, who have never served; (2) men who have completed 5 years' service with the colors and 13 years in the reserve. The ages of the men vary between 39 and 43 years.

The Finnish Military Service Law, whereby the Finnish army has lost the independence guaranteed by treaty, was promulgated on August 1, 1901. The offices of Finnish commander-in-chief and staff have been abolished.

The war strength of the Russian forces consists of about 56,500 officers and 2,855,000 men, including 1,792,000 infantry and 196,000 cavalry. These form the active army of all classes. To these figures must be added the available reserves, estimated at 1,064,000; frontier battalions, 41,000; Cossacks, 142,000. There are besides these the Territorial Reserves, some 2,000,000 men, and the Opoltchénie, 1,300,000, which could be employed in case of emergency. Gen. Redigers, a well-known authority, estimates the trained reserve to be 2,700,000. It is expected that under new organization the Opoltchénie, or militia, in time of war will form 40 infantry divisions, 640 battalions; 20 regiments of cavalry, 80 squadrons; 80 batteries of artillery, and 20 battalions of sappers; but owing to the vast distances to be covered, and the want of railway accommodations, the mobilization of this great force would be neither easy nor rapid. In regard to the embodiment of the reserve force in the event of war, great advances have been made by the establishment of brigade commands and the organization of reserve brigades.

### SERVIA.

The military forces consist of the national army and the militia (Opoltchénie).

The national army is divided into three levies: 1st, men from 20 to 30 years of age, and containing permanent cadres and a reserve; 2nd, men from 31 to 37 years; and 3rd, men from 38 to 45 years, with no constituted cadres in peace time.

The militia consists of men from 17 to 50 years of age not in the national army. No

substitution or buying off is allowed. The annual contingent is usually about 20,500 conscripts, of whom 6,000 are generally unfit for service.

The peace effective is difficult to calculate, because, for economic reasons, it is usual to send down men before their proper date for release. The units are strongest in the spring, and from then gradually dwindle away until a company barely consists of more than 10 or 15 men. The army is a species of semi-militia.

The war effective, according to official tables, the accuracy of which must be accepted with caution, amounts to 8,110 officers, 331,900 men, 420 guns, and 39,070 horses. The number of actual combatants would be about 228,000, but a very large proportion are of the 2d and 3d levies, with little or no training.

SPAIN.

Under the terms of an order of January 29, 1903, the army has been reorganized on the basis of an effective of 80,000 men; the second battalions of the infantry regiments and the fourth squadrons of the cavalry being reduced to skeleton formations. There are in all about 23,000 officers provided for the old establishment, but the supernumeraries are on half-pay, and their places are not being filled. There are eight captain-generalcies, but the eight army corps are replaced by divisions, and further reductions are being introduced. The headquarters are respectively: 1st, Madrid; 2nd, Seville; 3rd, Valentia; 4th, Barcelona; 5th, Saragossa; 6th, Burgos; 7th, Valladolid; 8th, Corunna.

The following is the constitution, by units, of the army: Infantry, 56 regiments, 20 battalions of Chasseurs, 4 African regiments, 2 regiments in the Balearic Islands, 2 regiments in the Canaries, recruiting cadres, etc. The cavalry, 28 regiments, and 3 squadrons for foreign possessions. Artillery, 13 field, 1 siege and 3 mountain regiments (all with four 6-gun batteries), 14 fortress battalions, 1 central gunnery school, 1 central remount committee, and 4 companies of artificers. The engineer corps consists of 4 regiments of sappers and miners, 1 pontoon regiment, 1 telegraph battalion, 1 railway battalion, 1 topographical brigade, 1 company of artificers, and 8 reserve depots, with 5 separate companies of sappers and miners for the Balearic Islands, etc. For recruiting purposes the Peninsula has 116 districts, the Canaries and Balearics have 2, and Ceuta and Melilla have 2. The total armed strength is estimated to be 500,000.

SWEDEN AND NORWAY.

Sweden.—The Swedish army underwent a reorganization in 1901, which is progressive and will have its full effect in 1914. General personal service has been adopted, with short periods with the colors: one year for service in the cavalry and artillery, and eight months for the infantry. The army will be substantially increased in strength. The 24 existing infantry regiments are to have a third battalion each, and 3 fortress regiments of similar strength are to be raised. Some of the new formations have already been brought into existence.

On a peace footing there are 2,606 officers, 1,797 non-commissioned officers, 6,947 corporals and others, 557 cadets, 7,792 volunteers, and 22,332 men, being a total of 40,031. The artillery are to receive Krupp quick-firing guns, of which the pattern is still under trial in an experimental battery. There are 4 corps of engineers. Steps are also to be taken to increase the body of reserve officers. One great object in the recent change is to give a more homogeneous character to the forces. The plans for mobilization of the reserves have been improved, and a Landsturm is being organized.

Norway.—The force now availabe for service beyond the frontier numbers, with officers and men, 25,109; but the total armed strength is estimated to be 38,000, There is, however, the defect that there is no reserve of the line to fill up the gaps which might arise during a war, without taking men from the militia (Landvaern). Besides the troops of the line there exists the militia or Landvaern for the defense of Norway, in case the troops of the line should be taken over to Sweden.

SWITZERLAND.

The federal forces do not constitute a standing army, the principle being that of a militia, and the liability to serve twelve years in the Elite, twelve in the Landwehr, and six in the Landsturm. During the twelve years in the Elite (ten for the cavalry) the aggregate service is 141 days in the infantry, 146 in the engineers, 160 in the cavalry, and 163 in the artillery.

The total military strength consists of: Elite (20 to 32 years of age): 96 battalions of infantry, 8 battalions of rifles, 24 squadrons of dragoons, 48 field batteries of 6 guns, 2 mountain batteries, 10 position batteries, and 12 companies of light horse. Landwehr (32 to 44 years of age): 96 battalions of infantry, 8 battalions of rifles, 24 squadrons of dragoons, 8 field batteries, and 15 position batteries. An aggregate total, in round numbers, of 200,000 men, of whom 130,000 are in the first 12 classes of the Elite, formed into 4 army corps. In addition, the Landsturm can furnish fully 300,000, giving an armed strength of 500,000, maintained at a cost of about $5,000,000 a year for a total population of 3,500,000.

TURKEY.

The Turkish military forces are organized on the territorial system, the whole empire being divided into seven territorial districts. By the recruiting law all Mussulmans are liable to military service. Christians and certain sects pay

an exemption tax. The nomad Arabs, although liable to service by law, furnish no recruits, and many Kurds evade service. The conscription therefore falls somewhat heavily on the Osmanlis, or Turks proper.

The men liable to service are divided into—(1) Nizam, or regular army, and its reserve; (2) Redif, corresponding to Landwehr; and (3) Mustahfiz, or Landsturm. There are also 660 Ilaveh battalions, mostly skeleton formations, in which men supplementary to the establishments are enrolled. Liability to service until recently commenced at twenty years of age, and lasted for twenty years—*i.e.*, with colors of the Nizam, four years; in the reserve of the Nizam, two years; in the Redif, four years in first class and four years in second class; and in the Mustahfiz, six years. An Iradé issued in November, 1903, increases the total Nizam service to nine years and the Redif service to nine years, it being estimated that this will add 250,000 men to the army. The cavalry are set down at 55,300; the artillery (174 field and 22 mountain batteries) at 54,720—1,356 guns; the engineers at 7,400; infantry, 583,200; total, 700,620. The Nizam has 320 battalions, 203 squadrons, and 248 batteries, and the Redif 374 battalions, 666 supplementary battalions (incomplete), and 48 squadrons. An irregular "Hamidieh" cavalry has been raised among the Kurds, and has 266 squadrons.

The total war strength is estimated to be: 46,400 officers, 1,531,600 men, 1,530 guns, and 109,900 horses. The Ottoman army has been trained and reorganized largely by German officers, and is composed of the best fighting material, as the war with Greece proved.

# CHAPTER V.

## THE RAILROADS OF THE WORLD.

In the Railroad Gazette (New York) for May 30, 1902, there appeared exhaustive tables, compiled from the Archiv für Eisenbahnwesen of Prussia, of the railroads of the world in the year 1900 and in previous years. With the help of these tables the Railroad Gazette, in its issue for June 6, makes the following comparative statements:

The mileage built in each decade has been for the world: Ten years to 1840, 4,772; 1850, 19,198; 1860, 43,160; 1870, 63,255; 1880, 101,081; 1890, 152,179; 1900, 107,421.

The mileage built before 1830, insignificant in amount, is included with the 4,772 miles credited above to the following decade.

Of the total of 491,066 miles completed at the end of the century more than one-half had been built since 1880 and nearly three-fourths since 1870. The total built in the forty years down to 1870 (130,385 miles) was one-seventh less than the construction in the single decade ending with 1890. It is notable, however, that in the last decade of the century 44,758 miles less were built than in the preceding ten years. This is one of the indications that the civilized and productive industrial countries of the world are now generally well equipped with these instruments of transportation. Europe (except Russia) and North America have immediate need of no large additions to their mileage. There is still abundant room for railroads in Asia, Africa and South America, but the slow growth of industries of these continents, two of which are over rather than under populated, but whose population is to a great extent a bar to progress such as Europe and North America have had in the past century, gives no promise of rapid railroad extension.

Nevertheless, the most notable development of the last decade has been the greater activity in Asia and Africa. In Asia, until after 1890, there was scarcely any railroad except in British India, a very little in Asia Minor, a beginning in Russia and Japan. But the 20,960 miles in Asia in 1890 had become 37,477 miles in 1900, and the 6,113 miles in Africa, 12,501. The additions, considering the size of the continents, are small; but they are only beginnings, and considerable new additions have been made since 1900, chiefly the Siberian Railroad in Asia and the Uganda in Africa. It is probably not generally known that even in this last decade it is India and not Russia which leads in railroad construction in Asia; India had added 6,982 miles (42 per cent) to the 16,781 it had in 1890, while the additions in Asiatic Russia were but 4,622 miles.

In Europe more railroad was built from 1890 to 1900 than in the previous decade, but less than from 1870 to 1880. The increase in the last decade was wholly due to Russia, where it was 10,659 miles, against 4,413 miles in the previous decade. In the rest of Europe 29,700 miles were built from 1880 to 1890, and only 26,418 in the following decade.

The most notable change in the last decade, however, is the decrease in construction in North America, which was so long the great field for railroad construction. With 2,834 miles built in 1840, the increase in mileage for successive decades has been: 1840-1850, 9,099; 1850-1860, 23,644; 1860-1870, 22,887; 1870-1880, 45,629; 1880-1890, 85,766; 1890-1900, 33,856.

Thus the new construction on this continent in the last decade was 60 per cent less than from 1880 to 1890, and even 20 per cent less than from 1870 to 1880. The decrease in the last decade was common to Canada and Mexico, as well as to the United States. It was altogether healthy. But this country and Canada, at least, are richer to-day than they would have been if they had built as much railroad in the last decade as

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United States, 184,532 miles. | Germany, 29,984 miles. | France, 25,862 miles. | Russia in Europe, 25,357 miles. | Great Britain, 23,534 miles. | British India, 21,543 miles.

Magnitude of the Leading Railroad Lines of the World Represented by Size of Locomotives.

RAILWAYS OF THE WORLD COMPARED IN THE YEAR 1899.

TOTAL NUMBER OF PASSENGER CARS.

Great Britain, 62,252.

Germany, 34,590.

United States, 33,893.

France, 28,750.

British India, 14,743.

Russia, 10,560.

TOTAL NUMBER OF FREIGHT CARS.

United States, 1,284,807.

Great Britain, 656,735.

France, 360,721.

Germany, 330,460.

Russia, 195,556.

British India, 80,053.

in the one preceding it. Fully $2,000,000,000 more than has actually been expended for new railroads would have been required; and the indications are that the capital thus saved has been most profitably employed in productive industries which give the railroads traffic to carry.

South and Central America (including West Indies) do not cut much of a figure in the railroad world, having now altogether only 29,071 miles, or less than Asia. Two-thirds of the South American mileage is in Argentina and Brazil.

Australia also has slackened its pace in railroad construction. It has room for more roads, but not people enough as yet to support them, and it grows slowly. It had 1,097 miles in 1870, added 3,780 by 1880, 6,863 more by 1890, and only 3,185 in the last decade of the century. Australia now has 14,925 miles.

The last annual return from the same source, published in June, 1903, shows the world's railroad mileage at the end of 1901.

Europe, 181,760 miles.

| Principal Countries. | Mileage of | Principal Countries. | Mileage of |
|---|---|---|---|
| Germany | 32,943 | Holland | 2,035 |
| Russia | 32,130 | Roumania | 1,982 |
| France | 27,285 | Turkey (including Bulgaria and Roumelia) | 1,963 |
| Austro-Hung'y | 23,432 | Denmark | 1,917 |
| Great Britain and Ireland | 22,164 | Portugal | 1,492 |
| Italy | 9,881 | Norway | 1,313 |
| Spain | 8,447 | Greece | 607 |
| Sweden | 7,242 | Servia | 361 |
| Belgium | 4,047 | | |
| Switzerland | 2,443 | | |

Total America (North and South), 256,643 miles.

| | | | |
|---|---|---|---|
| United States | 198,346 | Mexico | 9,660 |
| British North America | 18,397 | Brazil | 9,248 |
| Argentina | 10,479 | Chili | 2,896 |

Total Asia, 42,057 miles.

| | | | |
|---|---|---|---|
| British India | 25,515 | Japan | 4,093 |
| Siberia and Manchuria | 5,697 | Dutch Indies | 1,392 |
| | | China | 772 |

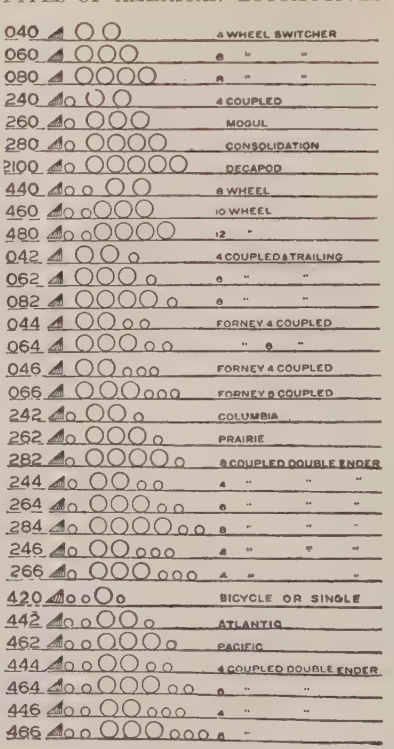
Total Africa, 14,270 miles.

| | | | |
|---|---|---|---|
| British South and Central Africa | 5,504 | Algiers and Tunis | 3,060 |
| | | Egypt | 2,903 |

Total Australia and New Zealand, 15,470 miles.

Grand Total of World's Railroads, 510,470 miles.

TYPES OF AMERICAN LOCOMOTIVES.




*—Encyclopedia Americana.*

## RAILWAY SIGNALS.

One blast of the whistle means "stop at once," or what is known as "down brakes"; two blasts of the whistle mean "off brakes"; three blasts of the whistle mean "back up"; a continuous blast means "danger." A semaphore signal at right angles to the post indicates danger; when the semaphore drops to an angle it is a signal to proceed. A red lantern indicates danger, as does a red flag; a green lantern or a green flag indicates "caution." Lanterns which are swung at right angles across the tracks mean "stop"; a lantern raised and lowered means "start"; when lanterns are swung in a circle it means "back the train."

## THE RAILROAD SYSTEM OF THE UNITED STATES.*

If one were called upon to name the field of engineering in which the vast scale upon which things are done in this country is most strikingly shown, he would be safe in pointing to the colossal railroad system of the United States. In respect of the total length of track, the total number of locomotives and cars, the veritable army of employees, and the gross value of capital invested, our railway system is so huge that it stands absolutely in a class by itself among the railroad systems of the world. It is equally true that in respect of the character of its track, rolling stock, its general equipment, and methods of operation, it is marked by national characteristics which distinguish it far more sharply from the great European and Asiatic roads, than they are distinguished from each other.

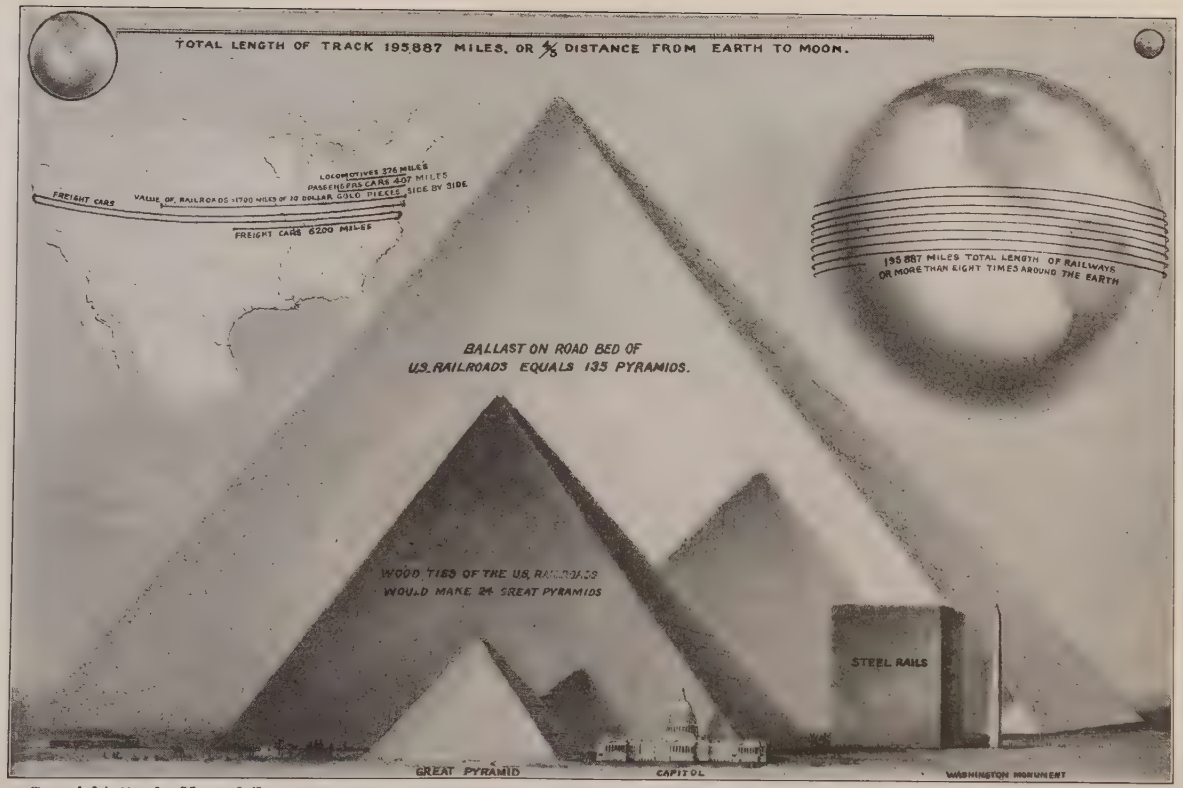
In attempting to impress upon the mind the magnitude of the properties and the operations represented by the statistics of such huge interests as the railroads of the United States, where the figures run into the millions and billions, it is necessary to translate these figures into concrete terms and refer them to some widely known standard of measurement, whether of distance, weight, or bulk. On the following pages, our artist has endeavored —and we think very successfully—to transform the statistics of our railroads into concrete form by taking as a unit of measurement the greatest single constructive work of man, the great Pyramid of Egypt, with whose dimensions every voting American citizen is perfectly familiar, or, if he is not, ought to be. From time immemorial the great Pyramid, being one of the original seven wonders of the world, has been a favorite standard of comparison with other great constructive works. It measures some 756 feet on the base by 481 feet in height, and contains about 91½ million cubic feet. Now, before we can use even this well-known standard and be sure that it will convey its full impression to the average reader, we must compare the Pyramid itself with some big and well-known structure, and for this purpose our artist has drawn the Capitol of Washington at the side of the Pyramid, both on the same scale. If it were possible to take a shell of the Pyramid, composed merely of the outer layer of stone, and place it over the Capitol, it would practically shut it out from view, and the apex of the Pyramid would extend 200 feet above the highest point of the Capitol dome.

The total length of the railroads in operation in the United States at the close of the fiscal year 1901 was 195,887 miles, this total not including track in sidings, etc. If these railroads could be stretched out in one continuous line, they would be sufficient to girdle the earth at the equator more than eight times; or, if started from the earth and stretched outward into space, they would reach four-fifths of the distance from the earth to the moon.

Steel Rails.—Now, to arrive at an estimate of what it has taken in material to build this length of railroad, let us assume that a fair average size of rail is one weighing 75 pounds to the yard. Much of the track in the Eastern States weighs 80, 90 and 100 pounds to the yard, while most of the track west of the Mississippi weighs 70, 60 and in some instances as low as 56 pounds to the yard. On this basis it is an easy calculation to determine that the total weight of these rails is over 25,000,000 tons; and if the mass were melted and cast in solid pyramidal form it would contain 105,540,000 cubic feet, and would be over 15 per cent larger than the great Pyramid itself. If the rails were cast in one rectangular block, it would form a mass 436 feet square on the base and equal in height to the Washington Monument, which towers 550 feet above its base.

Railroad Ties.—The railroad ties used in this country vary in size from a tie 8 inches wide, 6 inches deep and 9 feet long to ties as much as 12 inches in width and 8 inches in depth. A fair average would be a tie 10 inches in width and 7 inches in depth and 9 feet long, and a good average spacing would be 24 inches, center to center of the ties, or say 2,600 to the mile. On this basis we find that, could all these ties be gathered together on the Nile desert and piled one upon another into a pyramid of the same proportions as that at Gizeh, it would form a mass twenty-four times as great as the Pyramid of the Pharaohs, measuring 2,200 feet on its base and reaching 1,390 feet into the air.

* Reprinted from the "Transportation Number" of the *Scientific American*, Dec. 13, 1902, therefore the figures and the comparisons are for that year.


TOTAL LENGTH OF TRACK 195887 MILES. OR 1/8 DISTANCE FROM EARTH TO MOON.
LOCOMOTIVES 376 MILES
PASSENGERS CARS 457 MILES
FREIGHT CARS
VALUE OF RAILROADS 1700 MILES OF 10 DOLLAR GOLD PIECES SIDE BY SIDE
FREIGHT CARS 6200 MILES
195 887 MILES TOTAL LENGTH OF RAILWAYS
OR MORE THAN EIGHT TIMES AROUND THE EARTH
BALLAST ON ROAD BED OF
U.S. RAILROADS EQUALS 135 PYRAMIDS.
WOOD TIES OF THE U.S. RAILROADS
WOULD MAKE 24 GREAT PYRAMIDS
STEEL RAILS
GREAT PYRAMID
CAPITOL
WASHINGTON MONUMENT

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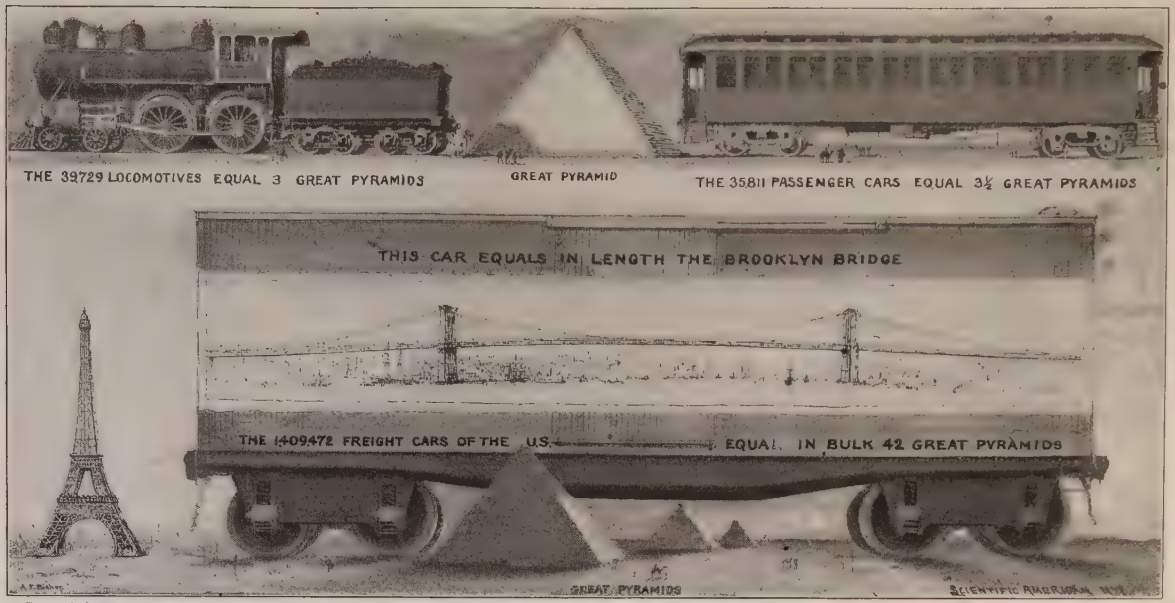
Comparisons Showing Length of Railroads and Bulk of Track.

THE GREAT RAILROAD SYSTEM OF THE UNITED STATES.


THE 39729 LOCOMOTIVES EQUAL 3 GREAT PYRAMIDS
GREAT PYRAMID
THE 35811 PASSENGER CARS EQUAL 3½ GREAT PYRAMIDS
THIS CAR EQUALS IN LENGTH THE BROOKLYN BRIDGE
THE 1409472 FREIGHT CARS OF THE U.S. EQUAL IN BULK 42 GREAT PYRAMIDS
GREAT PYRAMID
SCIENTIFIC AMERICAN

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Comparisons Showing Bulk of Equipment.

THE GREAT RAILROAD SYSTEM OF THE UNITED STATES.

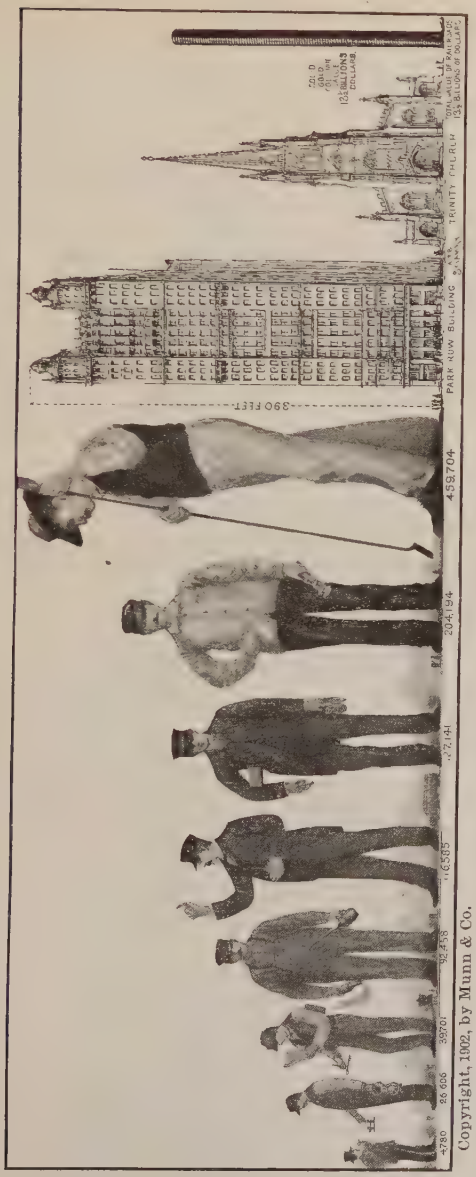
Rock and Gravel Ballast.—After the ties and rails have been laid in the construction of a railroad the ballast cars pass over it and unload their broken rock or gravel, which is tamped beneath and filled around the ties to form a solid but well-drained foundation. On some of our Eastern roads the depth of the ballast will exceed 18 or 20 inches; on the other hand, some of the Western roads have none at all, although of late years a vast advance has been made in the ballasting of the more cheaply constructed systems. Assuming an average depth of 12 inches of ballast, we find that if the railroad builders of the United States had concentrated their efforts, as did the Egyptians of old, on a single structure on the banks of the Nile, they would, in a period of years not much greater than that required to build the Pyramid, have raised a pyramid of their own 135 times greater in bulk than the tomb of Cheops. This vast pile would measure 3,900 feet on each side at the base, and would lift its head nearly half a mile into the air, or to be exact, just 2,500 feet. Were the spirit of the great Cheops to return to earth, and attempt to pace off the distance around the base, it would have to step out some 5,000 paces, or say three miles, to make the circuit; and should it climb to the summit, it would have to make a journey of about three-quarters of a mile. So much for the roadbed and the track. Now let us turn our attention to the equipment.

Locomotives.—At the close of the fiscal year 1901, there were in service on the United States railroads 39,729 locomotives. Assuming that the average locomotive fills a block 10 feet wide by 15 feet high by 50 feet long, and that all these locomotives could be brought into review at Gizeh and there piled up into one great block, a locomotive that would fill that block would be 510 feet in height and 1,700 feet, or, say, a third of a mile, in length, its smokestack towering 29 feet above the summit of the Pyramid.

Passenger Cars.—There are 35,800 passenger, mail and baggage cars on our railroads, and a typical car representing the space occupied by these would be 500 feet high and 1,950 feet in length, and it would take 3 1-2 great Pyramids to equal it in bulk.

Freight Cars.—As far as the equipment is concerned it is in the extraordinary number of the freight cars employed that we get the best idea of the great scale upon which our railroads are operated. The total number of cars is 1,409,472. They vary, of course, considerably in size, capacity and type, there being in addition to the familiar box car, the coal cars of various size and type, the freight cars, and a small number of miscellaneous cars for railroad construction and other purposes. A single box car representing the space occupied by all these freight cars would be two-thirds of a mile in length and one-quarter of a mile in height. The Pyramid of Cheops would reach about to the floor of the car. Were the Eiffel Tower set alongside of it, it would reach only two-thirds of the distance to its roof, while the whole Brooklyn Bridge, with its anchorages, could be placed bodily inside the car, and if the foundations of its piers rested upon the car floor, the summit of its towers would still reach only half way to the roof of the car.

Employees.—It requires over one million employees for the maintenance and operation of our railroads. Of these nearly one-half are engaged upon the track and roadbed, in proportions made up as follows: There are 33,817 section foremen, each of whom has a stretch of a few miles of track under his charge, and a gang of from five to eight or ten section men, his duties being those of maintaining the track in proper level and line, seeing that the track bolts are kept tight, the joints in good order, and that the roadbed is properly trimmed, graded and drained. The total number of trackmen employed in the section gangs, as they are called, is 239,166. There are also 47,576 switchmen, flagmen and watchmen, who are engaged in switching work at the yards, in guarding the level crossings, and in patrolling the track. There are also over 7,423 men employed on work trains and other work incidental to track maintenance. In addition to these there are 131,722 laborers engaged in construction and repair and maintenance work of various kinds, making a total engaged on track work and general labor connected therewith of 459,704 men. Carrying out our system of comparison with some standard of bulk, we have chosen the Park Row Building, New York, which has a total height of 390 feet. If this army of trackmen and laborers were combined in one typical giant, he would be some 385 feet in height and of proportionate weight and bulk. The next largest item is the




THE EMPLOYEES AND THE MONEY VALUE OF THE UNITED STATES RAILROADS.

machinists, of which there are 34,698, the carpenters, of which there are 48,946, and various other shopmen engaged in the repair and general maintenance of the rolling stock to the number of 120,550, making a total number of skilled and unskilled men in the railroad shops of 204,194. The next largest total is that of the station agents, baggage masters, porters, etc., there being 32,294 station agents and 94,847 baggage masters, porters, etc. Then follow the conductors and brakemen, 32,000 of the former and 84,493 of the latter. There are 92,458 enginemen and firemen, 45,292 of the former and 47,166 of the latter. Employed in the general offices of the various railroad companies, in performing the vast amount of clerical work required, there are 39,701 clerks, while sheltered under the same roof is a body of men upon whom as much as or more than any other in the whole army of railroad employees falls the responsibility of the safety of trains and passengers—the telegraph operators and dispatchers, of whom there are altogether 26,606. The smallest in number, but controlling the whole of this vast organization, are the general officers, presidents, vice-presidents, treasurers, secretaries, etc., of whom there are 4,780.

Money Value.—Perhaps, after all, the most remarkable figures are those which show the total value of the railroad system of the United States, which expressed in figures is 13,308,029,032 dollars. If this sum were represented in ten-dollar gold pieces, and these pieces were set on edge, side by side, they would reach more than half way from New York to San Francisco, or 1,700 miles. Or, were this coin melted and run into a single casting, it would form a column 15 feet in diameter and 259 feet in height.

## ABSTRACT OF STATISTICS OF RAILWAYS IN THE UNITED STATES FOR THE YEAR ENDING JUNE 30, 1904.

From summaries which will be included in the Seventeenth Annual Statistical Report of the Interstate Commerce Commission, prepared by its statistician as the complete report for the year ending June 30, 1904, the figures in this abstract are obtained:

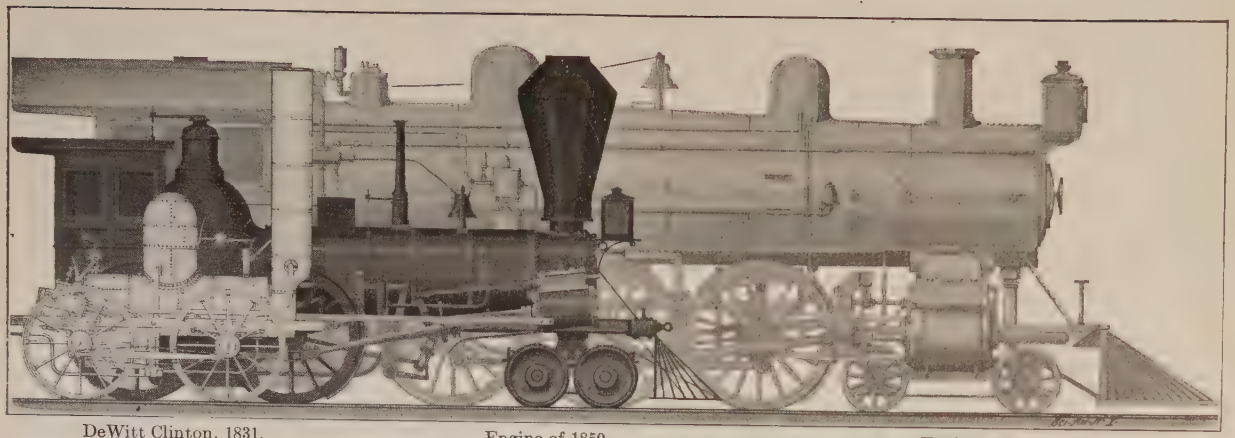
### MILEAGE AND CAPITALIZATION OF ROADS.

The total single-track railway mileage in the United States on June 30, 1904, was 213,904.34 miles, having increased 5,927.12 miles in the year ending on that date. This increase exceeds that of any previous year since 1890. The 19 States and Territories for which an increase in mileage exceeding 100 miles is shown are Alabama, Arkansas, California, Illinois, Iowa, Louisiana, Minnesota, Mississippi, Missouri, North Dakota, Ohio, Pennsylvania, Tennessee, Texas, Utah, West Virginia, Indian Territory, New Mexico, and Oklahoma. Most of the railway mileage of the country, excepting that of street lines, is covered by reports rendered to the Commission by the carriers.

For the year under consideration the operated mileage, concerning which substantially complete returns were made, was 212,243.20 miles, including 6,638.34 miles of line on which trackage privileges were exercised. The aggregate length of railway mileage, including tracks of all kinds, was 297,073.34 miles, being classified as follows: Single track, 212,243.20 miles; second track, 15,824.04 miles; third track, 1,467.14 miles; fourth track, 1,046.50 miles, and yard track and sidings, 66,492.46 miles. Thus it appears that there was an increase of 13,251.82 miles in the aggregate length of all tracks, of which 4,932.40 miles, or 37.22 per cent., were due to the extension of yard track and sidings.

The number of railway corporations included in the report was 2,104. Of this number 1,086 maintained operating accounts, 848 being classed as independent operating roads and 238 as subsidiary roads. Of roads operated under lease or some other form of contract 318 received a fixed money rental, 147 a contingent money rental, and 257 were operated under conditions not readily classified. In the course of the year railway companies owning 5,600.18 miles of line were reorganized, merged, consolidated, etc. For the year 1903 the corresponding item was 10,486.37 miles.

The length of mileage operated by receivers on June 30, 1904, was 1,323.28 miles, showing an increase of 137.83 miles as compared with the previous year. The number of roads in the hands of receivers was 28, and at the close of the previous year 27, six roads having been taken from the



| DeWitt Clinton, 1831. | Engine of 1850. | Engine of 1902. |
|---|---|---|
| Cylinders, 5½x16 inches. | Cylinders, 16x20 inches. | Cylinders, 22x28 inches |
| Drivers, 54 inches. | Drivers, 66 inches. | Wheels, 72 inches |
| Boiler pressure, 80 pounds. | Boiler Pressure, 100 pounds | Boiler pressure, 200 pounds. |
| Tractive effort = 919 pounds. | Tractive effort = 7,758 pounds. | Tractive effort = 32,000 pounds. |

SEVENTY-ONE YEARS' GROWTH OF THE AMERICAN LOCOMOTIVE.

hands of receivers and seven having been placed in charge of the courts.

EQUIPMENT.

On June 30, 1904, there were in the service of the railways 46,743 locomotives, the increase being 2,872. As classified, these locomotives were: Passenger, 11,252; freight, 27,029; switching, 7,610. There were also 852 not assigned to any class.

The total number of cars of all classes was 1,798,561, this total having increased 45,172 during the year. The assignment of this rolling stock was, to the passenger service, 39,752 cars; to the freight service, 1,692,194 cars; the remaining 66,615 cars being those employed directly by the railways in their own service. Cars used by the railways that were owned by private companies and firms are not included in this statement. The average number of locomotives per 1,000 miles of line was 220, showing an increase of six. The average number of cars per 1,000 miles of line was 8,474, showing a decrease of 66 as compared with the previous year. The number of passenger-miles per passenger locomotive was 1,948,384, showing a decrease of 30,402 miles. The number of ton-miles per freight locomotive was 6,456,846, showing a decrease of 351,096 miles as compared with June 30, 1903.

The aggregate number of locomotives and cars in the service of the railways was 1,845,304. Of this number 1,554,772 were fitted with train brakes, indicating an increase during the year of 92,513, and 1,823,030 were fitted with automatic couplers, indicating an increase of 52,472. Practically all locomotives and cars in passenger service had train brakes, and of the 11,252 locomotives in that service 11,113 were fitted with automatic couplers. Only 602 cars in passenger service were without automatic couplers. With respect to freight equipment it appears that most of the freight locomotives had train brakes and automatic couplers. Of 1,692,194 cars in freight service on June 30, 1904, 1,434,386 had train brakes and 1,674,427 automatic couplers. In this report there have been continued several summaries, first presented in the report for 1902, to show the general type and efficiency of locomotives and the capacity of freight cars.

In these summaries locomotives are classified under the heads of single-expansion locomotives, four-cylinder compound locomotives, and two-cylinder compound or cross-compound locomotives. Each of these classes of locomotives is further classified according to the number of drivers and the number of pilot wheels and trailers.

Freight cars are first classified as box cars, flat cars, stock cars, coal cars, tank cars, refrigerator cars, and other cars. The cars in these classes are further distributed among the requisite number of sub-classes, the lowest of which, Class I, being for cars having capacities in the 10,000's of pounds; Class II for cars in the 20,000's of pounds, the other classes successively increasing in the same ratio.

EMPLOYEES.

The number of persons on the payrolls of the railways in the United States, as returned for June 30, 1904, was 1,296,121, or 611 per 100 miles of line. These figures, when compared with corresponding ones for the year 1903, show a decrease of 16,416 in the number of employees, or 28 per 100 miles of line. The classification of employees includes enginemen, 52,451; firemen, 55,004; conductors, 39,645, and other trainmen, 106,734. There were 46,262 switch tenders, crossing tenders, and watchmen. With regard to the four general divisions of railway employment, it appears that general administration required the services of 48,746 employees; maintenance of way and structures, 415,721 employees; maintenance of equipment, 261,819 employees, and conducting transportation, 566,798 employees. This statement disregards a few employees of which no assignment was made.

The usual statement of the average daily compensation of the 18 classes of employees for a series of years is continued in the present report, which shows also the aggregate amount of compensation paid to more than 99 per cent. of the number of employees for the year 1904, 97 per cent. for the year 1903, and more than 99 per cent. for the five years preceding. The amount of wages and salaries paid to employees during the year ending June 30, 1904, as reported, was $817,598,810.

CAPITALIZATION OF RAILWAY PROPERTY.

The par value of the amount of railway capital outstanding on June 30, 1904, was $13,213,124,679, which represents a capitalization of $64,265 per mile for the railways in the United States. Of this capital $6,339,899,329

existed as stock, of which $5,050,529,469 was common and $1,289,369,860 preferred, and the remaining part, $6,873,225,350 as funded debt, which consisted of mortgage bonds, $5,746,898,983; miscellaneous obligations, $723,114,986; income bonds, $229,876,687, and equipment trust obligations, $173,334,694. Current liabilities are not included in railway capital for the reason that this class of indebtedness has to do with the operation rather than with the construction and equipment of a road. Current liabilities for the year amounted to $881,628,720, or $4,288 per mile of line.

Of the total capital stock outstanding $2,696,472,010, or 42.53 per cent., paid no dividends. The amount of dividends declared during the year was $221,941,049, being equivalent to 6.09 per cent. on dividend-paying stock. For the year ending June 30, 1903, the amount of dividends declared was $196,728,176. Of the total amount of stock outstanding, $6,339,899,329, 5.80 per cent. paid from 1 to 4 per cent.; 14.65 per cent. from 4 to 5 per cent.; 10.64 per cent. from 5 to 6 per cent.; 8.50 per cent. from 6 to 7 per cent., and 9.80 per cent. from 7 to 8 per cent. The amount of funded debt (omitting equipment trust obligations) that paid no interest was $300,894,215, or 4.49 per cent. Of mortgage bonds, $175,817,862, or 3.06 per cent.; of miscellaneous obligations, $61,048,625, or 8.44 per cent., and of income bonds, $64,027,728, or 27.85 per cent., paid no interest.

Of the total amount of railway stock outstanding, $1,942,858,359 were reported as owned by railway corporations, and of the railway bonds, $558,472,242 were so reported.

### PUBLIC SERVICE OF RAILWAYS.

The number of passengers reported as carried by the railways in the year ending June 30, 1904, was 715,419,682, indicating an increase of 20,528,147 as compared with the year ending June 30, 1903. The passenger-mileage, or the number of passengers carried one mile, was 21,923,213,536, having increased 1,007,449,655.

The number of tons of freight reported as carried (including freight received from connecting roads and other carriers) was 1,309,899,165, which exceeds the tonnage of the previous year by 5,504,842 tons. The ton-mileage, or the number of tons carried one mile, was 174,522,089,577, the increase being 1,300,810,584. The number of tons carried one mile per mile of line was 829,476, which figures indicate a decrease in the density of freight traffic of 25,966 ton-miles per mile of line.

The average revenue per passenger per mile for the year mentioned was 2.006 cents, the average for the preceding year being the same. The average revenue per ton per mile was 0.780 cent. This average for the preceding year was 0.763 cent. Earnings per train-mile show an increase for passenger but a decrease for freight trains. The average cost of running a train one mile appears to have increased between 4 and 5 cents. The ratio of operating expenses to earnings, 67.79 per cent., also increased in comparison with the preceding year, when it was 66.16 per cent.

A summary of freight traffic, classified on the basis of a commodity classification embracing some 38 items, is continued for the year under review.

### EARNINGS AND EXPENSES.

The gross earnings of the railways in the United States from the operation of 212,243.20 miles of line were, for the year ending June 30, 1904, $1,975,174,091, being $74,327,184 greater than for the previous year. Their operating expenses were $1,338,896,253, or $81,357,401 more than in 1903. The following figures give gross earnings in detail, with the increase of the several items as compared with the previous year: Passenger revenue, $444,326,991—increase, $22,622,399; mail, $44,499,732—increase, $2,790,336; express, $41,875,636 — increase, $3,543,672; other earnings from passenger service, $10,914,746 — increase, $1,093,469; freight revenue, $1,379,002,693—increase, $40,982,667; other earnings from freight service, $4,568,282—increase, $101,257; other earnings from operation, including unclassified items, $49,986,011 — increase, $3,193,384. Gross earnings from operation per mile of line averaged $9,306, the corresponding average for the year 1903 being $48 less.

The operating expenses were assigned to the four general divisions of such expenses, as follows: Maintenance of way and structures, $261,280,454; maintenance of equipment, $267,184,739; conducting transportation, $758,238,681; general expenses, $51,579,196; undistributed, $613,183. Operating expenses were $6,308 per mile of line, having increased $183 per mile in com-

parison with the preceding year. The statistical report contains an analysis of the operating expenses for the year according to the fifty-three accounts prescribed in the official classification of these expenses, with the percentage of each item of the expenses as classified for the years 1898 to 1904.

The income from operation, or the net earnings, of the railways amounted to $636,277,838. This item, when compared with the net earnings of the year 1903, shows a decrease of $7,030,217. Net earnings per mile for 1904 averaged $2,998; for 1903, $3,133, and for 1902, $3,048. The amount of income obtained from other sources than operation was $212,933,990. In this amount are included the following items: Income from lease of road, $109,694,361; dividends on stocks owned, $44,969,794; interest on bonds owned, $18,702,245, and miscellaneous income, $39,567,590. The total income of the railways, $849,211,828—that is, the income from operation and from other sources—is the amount from which fixed charges and similar items of expenditure are deducted to ascertain the sum available for dividends. Deductions of such nature totalized $570,425,902, leaving $278,785,926 as the net income for the year available for dividends or surplus.

The amount of dividends declared during the year (including $115,546, other payments from net income) was $222,056,595, leaving as the surplus from the operations of the year ending June 30, 1904, $56,729,331, that of the previous year having been $99,227,469. The amount stated above for deductions from income, $570,425,902, comprises the following items: Salaries and maintenance of organization, $453,341; interest accrued on funded debt, $297,674,738; interest on current liabilities, $13,945,009; rents paid for lease of road, $110,857,803; taxes, $61,696,354; permanent improvements charged to income account, $38,522,548; other deductions, $47,276,109.

It is perhaps appropriate to mention that the foregoing figures for the income and expenditures of the railways, being compiled from the annual returns of leased roads as well as of operating roads, necessarily include duplications in certain items of income and also of expenditure, since, in general, the income of a leased road is the rent paid by the company which operates it. The report, however, includes a summary presenting the income account of the railways considered as a single system, from which intercorporate payments are eliminated.

The summary showing the taxes and assessments of the railways by States and Territories and per mile of line, and also the analysis of taxes showing the basis of payments according to the various laws under which railways are taxed, are repeated in the present report.

### RAILWAY ACCIDENTS.

The casualties returned by the carriers in their annual reports to the Commission embrace casualties sustained by passengers, employees, trespassers, and other persons. These returns are not comparable with figures given in the quarterly accident bulletins that are based on monthly reports, which are mainly confined to casualties to passengers and to employees actually on duty on or about trains.

The total number of casualties to persons on the railways for the year ending June 30, 1904, was 94,201, of which 10,046 represented the number of persons killed and 84,155 the number injured. Casualties occurred among three general classes of railway employees, as follows: Trainmen, 2,114 killed and 29,275 injured; switch tenders, crossing tenders, and watchmen, 229 killed, 2,070 injured; other employees, 1,289 killed, 35,722 injured. The casualties to employees coupling and uncoupling cars were: Employees killed, 307; injured, 4,019. The casualties connected with coupling and uncoupling cars are assigned as follows: Trainmen killed, 269; injured, 3,506; switch tenders, crossing tenders, and watchmen killed, 23; injured, 420; other employees killed, 15; injured, 93.

The casualties due to falling from trains, locomotives, or cars in motion were: Trainmen killed, 457; injured, 4,757; switch tenders, crossing tenders, and watchmen killed, 25; injured, 301; other employees killed, 75; injured, 570. The casualties due to jumping on or off trains, locomotives, or cars in motion were: Trainmen killed, 116; injured, 3,926; switch tenders, crossing tenders, and watchmen killed, 14; injured, 278; other employees killed, 61; injured, 506. The casualties to the same three classes of employees in consequence of collisions and derailments were: Trainmen killed, 613; injured, 4,337; switch tenders, crossing tenders, and watchmen killed, 20; injured, 138; other employees killed, 90; injured, 854.

The number of passengers killed in

the course of the year 1904 was 441 and the number injured 9,111. In the previous year 355 passengers were killed and 8,231 injured. There were 262 passengers killed and 4,978 injured because of collisions and derailments. The total number of persons, other than employees and passengers, killed was 5,973; injured, 7,977. These figures include the casualties to persons classed as trespassing, of whom 5,105 were killed and 5,194 were injured. The total number of casualties to persons other than employees from being struck by trains, locomotives, or cars was 4,749 killed and 4,179 injured. The casualties of this class were as follows: At highway crossings, passengers killed, 4; injured, 10; other persons killed, 804; injured, 1,453; at stations, passengers killed, 28; injured, 108; other persons killed, 458; injured, 525; at other points along track, passengers killed, 9; injured, 38; other persons killed, 3,446; injured, 2,045. The ratios of casualties indicate that one employee in every 357 was killed and one employee in every 19 was injured. With regard to trainmen—that is, enginemen, firemen, conductors, and other trainmen—it appears that one trainman was killed for every 120 employed and one was injured for every nine employed.

In 1904, one passenger was killed for every 1,622,267 carried, and one injured for every 78,523 carried. For 1903 the figures show that 1,957,441 passengers were carried for one killed, and 84,424 passengers were carried for one injured. For 1895, one passenger was killed for every 2,984,832 carried and one injured for every 213,651 carried. With respect to the number of miles traveled the figures for 1904 show that 49,712,502 passenger-miles were accomplished for each passenger killed, and 2,406,236 passenger-miles for each passenger injured. For 1903 the figures were, 58,917,645 passenger-miles for each passenger killed, and 2,541,096 passenger-miles for each passenger injured. The figures for 1895 show that 71,696,743 passenger-miles were accomplished for each passenger killed and 5,131,977 passenger-miles for each passenger injured.

## INTERESTING FACTS CONCERNING RAILWAYS.

Differences of Gauge.—It is not really known what, if any, principle governed the determination in the first instance of the gauge between the rails of 4 ft. 8½ ins., which is the standard railway gauge of the world. It is supposed to have been adopted from the roads of the collieries in the north of England, whose uniform width necessitated the use of wagons having axles of an outside width of 5 feet. In places these wagons ran on tramways, with a flange on the outer edge of the rail. Then came the edge rail, which transferred the flange to the wheel. However, the same width of track was continued, but measured from the inner edge of the rail it gave a gauge of 4 ft. 8½ ins. When Stephenson was selected from these collieries to build the Liverpool and Manchester railway, he brought with him the gauge with which he was familiar.

The 4 ft. 8½ ins. gauge is the standard one in Europe, with but few exceptions, and in North America, and throughout the world generally, though every country possesses lines of narrower gauges. European countries having a different gauge are Ireland, 5 ft. 3 ins., Russia, 5 ft., and Spain, 5 ft. 6 ins. The standard gauge of India is 5 ft. 6 ins., while there are also a number of railways whose mileage amounts to 42 per cent. of the whole, built on the 3 ft. 3⅜ ins. gauge. In New Zealand, Tasmania, South Africa and the Sudan the standard gauge is 3 ft. 6 ins. Australia has no standard gauge. In New South Wales the gauge is 4 ft. 8½ ins., in Queensland 3 ft. 6 ins., and in Victoria. 5 ft. 3 in.

### CAPE TO CAIRO RAILWAY.

The Cape to Cairo Railway, which was the late Mr. Rhodes's scheme for joining the south and north of Africa, a distance of nearly 5,000 miles, is making rapid progress. Northwards from the Cape the line has been carried forward by the Chartered Company to the Wankie coal-fields, which are 200 miles north of Buluwayo (or 1,560 miles north from the sea), and some 70 miles south of the Victoria Falls. The southern bank of the Zambesi River has been reached at the Victoria Falls. In the north the railway only runs as far as Khartoum, and in spite of the agreement with Abyssinia permitting the making of a line through its territory, no extension south is likely in the present generation.

Mr. Rhodes's idea was to fit the main lines with branches to the coast; there will be many of these in time. Two are finished, the Uganda Railway (British) and the Beira-Salisbury line (Portuguese); others are planned, such as the Congo-Katanga Railway (Belgian) to Rhodesia and one through German East Africa. The Cape to Cairo telegraph is rapidly approaching completion; it has now reached Central Africa.

## TRANS-SIBERIAN RAILWAY.

The opening of the Trans-Siberian Mail route promises to accelerate the transmission of European letters to and from the north of China. A letter posted from Tientsin on the 30th August, 1902, and forwarded by this route, was delivered in Liverpool on the 28th September—just 28 days later. The transmission of letters via Brindisi or via Vancouver usually takes from 36 to 40 days. Therefore, the Trans-Siberian Railway saves at least a week, which is a matter of great importance to commercial houses. Delivery is, however, erratic, and no working arrangement has yet been arrived at between the Post Offices of Great Britain and Russia. All that the former does is to forward letters marked "Via Siberia" by the Russian route; all others go by sea.

On Sept. 27th, 1903, the mails to the Far East were despatched from Paris (Nord) for the first time via Berlin and Moscow.

Moscow is the western terminus of the Trans-Siberian Railway, the main line of which extends thence to Dalny, a distance of 5,403 miles. The Manchuria-Dalny section, 1,171 miles, embraces the following important junctions: Harbin, for Vladivostok via Grodekovo; Tachitchiao, for Pekin via Inkoo (Newchang), and Nangaline for Port Arthur.

The most direct route from London to Moscow is via Dover, Ostend, Berlin, Alexandrowo, Warsaw, and Brest Litewski. The distance is 1,800 miles, and the through journey occupies 67 hours.

The Coast terminals of the Trans-Siberian Railway, viz., Dalny, Vladivostok, and Port Arthur, are also ports of call with various steamship companies, whose boats are arranged to connect with the train service generally. Thus, the boats of the East China Railway Company ply between Dalny and Shanghai, Dalny and Nagasaki, and Dalny, Port Arthur, and Chifu, and between Vladivostok and Shanghai. The "Oiye" (Japan) Line call at Vladivostok and sail to and from all Japanese ports. The Russian Volunteer fleet has a steamship service between Odessa and Vladivostok, calling at Singapore, Port Arthur, and Nagasaki. The "Nipon Yusen-Kaisha" Company furnish boats between Kobe, Nagasaki, Fusan, Gensan, and Vladivostok, and between Kobe, Chifu, Dalny, Port Arthur, and Taku. The Hamburg-American Line gives a service between Hongkong and Vladivostok.

Fares from London, via Dover, Ostend, and Alexandrowo:

| | 1st Class. | 2d Class |
|---|---|---|
| To Dalny | $195 | $135 |
| To Pekin | 200 | 140 |
| To Port Arthur | 200 | 140 |
| To Vladivostok | 185 | 125 |
| To Shanghai | 215 | 150 |
| To Nagasaki | 215 | 150 |

The Circum-Baikal Railway was opened Sept. 25th, 1904. The road is 161 miles long. The Manchurian Railway itself is in a very bad condition, owing to poor construction. Days and sometimes weeks of delay are common. The Siberian main line, now single, is to be doubled.

New Trans-Canadian Railway.—The Grand Trunk Railway Company has secured the assent of the Dominion Parliament to the construction of a new railroad straight across Canada, from New Brunswick in the east to the Pacific Ocean in the west. The Government will themselves be the owners of the whole line from New Brunswick to Winnipeg, but the line is to be leased to and worked by the Grand Trunk Pacific. The Grand Trunk Pacific will be restricted in its possession and ownership of the road west of Winnipeg.

Sahara Railway.—A project which is being much discussed in France is a railway across the Sahara. Three routes have been suggested, one from Igli to the Niger, one from Biskra, 214 miles southeast of Algiers, to th west shore of Lake Chad, and the third from Bizerta in Tunis to Lake Chad. M. Paul Bonnard, an expert in African affairs, recommends the latter, as it would connect the French possessions in North Africa with the French Congo, and thus become a trans-African railway. —*Daily Mail Year Book.*

## STREET AND ELECTRIC RAILWAYS IN THE UNITED STATES, 1902.

The statistics contained in this section cover all street and electric railways in the United States that were in operation during any part of the year ending June 30, 1902. The term "street and electric railways" as here used includes all electric railways irrespective of their length or location, and all street railways irrespective of their motive power. At the census of 1890 the railroads that used motive power other than steam were confined almost exclusively to urban districts and were properly classed as "street railways," but the application of electricity has enabled these roads to greatly extend their lines in rural districts, and a large proportion of the trackage is now outside the limits of cities, towns, or villages. That the use of electric power has been the principal factor in the development of these railways during the past few years is shown by the table which presents for the years 1890 and 1902, the number of companies and miles of single track in the United States, segregated according to character of motive power which is employed.

NUMBER OF COMPANIES AND MILES OF SINGLE TRACK GROUPED ACCORDING TO MOTIVE POWER: 1890 AND 1902.

| CHARACTER OF POWER. | 1902 | | 1890 | | PER CENT OF INCREASE. | |
|---|---|---|---|---|---|---|
| | Number of companies. | Miles of single track. | Number of companies. | Miles of single track. | Number of companies. | Miles of single track. |
| United States | 849 | *22,589.47 | 761 | 8,123.02 | 11.6 | 178.1 |
| Electric | 747 | †21,920.07 | 126 | 1,261.97 | 492.9 | 1,637.0 |
| Animal | 67 | 259.10 | 506 | 5,661.44 | ‡86.8 | ‡95.4 |
| Cable | 26 | 240.69 | 55 | 488.31 | ‡52.7 | ‡50.7 |
| Steam | 9 | 169.61 | 74 | 711.30 | ‡87.8 | ‡76.2 |

* Includes 12.48 miles of track duplicated in reports of different companies.
† Includes 6.06 miles operated by compressed air.
‡ Decrease.

At both censuses some companies reported the use of more than one kind of power, and in order to show the total number of companies for each class, they have been counted more than once; therefore the total given in table above exceeds the actual number of separate companies. The increase in the length of track is confined entirely to the roads operated by electric power. The use of electric power was reported by 126 companies in 1890 and 747 in 1902. The single track mileage operated by this power increased from 1,261.97 miles in 1890 to 21,920.07 in 1902. A decided decrease is shown in the number of companies and the trackage for each of the other classes of power.

The length of single track, 22,589.47 miles, reported for 1902, consists of 16,651.58 miles of first main track, 5,030.36 miles of second main track, and 907.53 miles of sidings and turnouts. The second table reproduces the totals for the United States and shows the mileage of each of the different classes of track and the per cent which each class forms of the total.

SINGLE-TRACK MILEAGE AND PER CENT. WHICH EACH CLASS IS OF TOTAL: 1902.

| CLASS OF TRACK. | Single-track mileage. | Per cent of total. |
|---|---|---|
| Total | *22,589.47 | 100.0 |
| First main track | 16,651.58 | 73.7 |
| Second main track | 5,030.36 | 22.3 |
| Sidings and turnouts | 907.53 | 4.0 |
| Overhead trolley | 21,302.57 | 94.3 |
| Other electric power | 611.44 | 2.7 |
| Compressed air | 6.06 | (†) |
| Animal | 259.10 | 1.1 |
| Cable | 240.69 | 1.1 |
| Steam | 169.61 | .8 |
| Trackage owned | 19,038.33 | 84.3 |
| Trackage leased | 3,551.14 | 15.7 |
| Operated under trackage rights | 560.92 | 2.5 |
| Constructed and opened for operation during the year | 1,549.73 | 6.9 |
| On private right of way owned by company | 3,424.96 | 15.2 |
| On private right of way not owned by company | 377.11 | 1.7 |
| Located within city limits | ‡13,208.24 | 65.8 |
| Located outside city limits | ‡6,855.58 | 34.2 |
| Equipped with cast welded joints | 1,642.68 | 7.3 |

* Includes 12.48 miles of track duplicated in reports of different companies.
† Less than one-tenth of 1 per cent.
‡ Exclusive of the mileage of Massachusetts.

Of the total single-track mileage, 21,914.01 miles, or 97 per cent, were operated by electric power and 416.36 miles, or 1.9 per cent, by other mechanical traction, while only 259.10 miles, or 1.1 per cent, were operated by animal power, as compared with 69.7 per cent in 1890. Of the total trackage in use by all companies, 84.3 per cent was owned by the operating companies and 15.7 per cent leased. The mileage of track constructed and opened for operation during the year covered by this report was 1,549.73 miles, or 6.9 per cent of the total, but this does not cover all of the track under construction. A number of miles of track were in various stages of completion, but it was impracticable to fix upon any stage of the work at which the trackage could be enumerated other than that of actual completion. The statistics concerning track located on private right of way refer particularly to rural electric railways, many of which have bought or have had surrendered to them a separate roadbed, either adjoining or independent of the highway, in the same manner as a steam railroad. It appears from the reports that 3,424.96 miles of single track were on private right of way owned by the company. Occasionally the railway is built on a private right of way not owned by the company, an example of which would be a toll bridge owned by a bridge company, to whom payment for the privilege of using it was made. There were 377.11 miles of single track on right of way of this character.

The inquiries concerning the location of track, whether within or without city limits, were made with the intention of ascertaining the relative length of track operated in urban and rural districts, respectively. In a number of cases it was impossible to determine exactly the trackage that should be assigned to these two subdivisions. In some instances the track was within or passed through thickly settled communities that were not organized as cities or towns, and therefore had no legal limits, and it was difficult to obtain the length that should be considered as within the urban district. In the New England states densely populated communities are legally part of the town government, which includes also rural districts. Many companies in Massachusetts reported that it was impracticable to make the distinction, and accordingly the trackage for that state has not been included in this classification. For the United States, exclusive of Massachusetts, 13,208.24 miles of single trackage, or 65.8 per cent of the total, were reported as within urban limits and 6,855.58 miles, or 34.2 per cent, as outside of such limits.

The increase in the trackage is due not only to the establishment of new companies, but very largely to the extension of the lines of established companies.

COMPANIES GROUPED ACCORDING TO LENGTH OF LINE: 1890 AND 1902.

| LENGTH OF ROAD BED. | 1902 | | 1890 | |
|---|---|---|---|---|
| | Number of companies. | Length of line. | Number of companies. | Length of line. |
| Total | *817 | 16,651.58 | †691 | ‡5,119.53 |
| Under 10 miles | 394 | 1,957.16 | 557 | 2,304.49 |
| 10 to 20 miles | 219 | 3,148.94 | 99 | 1,353.42 |
| Over 20 to 30 miles | 76 | 1,878.54 | 16 | 400.39 |
| Over 30 to 40 miles | 34 | 1,197.83 | 7 | 251.74 |
| Over 40 to 50 miles | 25 | 1,117.05 | 4 | 178.04 |
| Over 50 to 60 miles | 16 | 892.86 | 2 | 101.57 |
| Over 60 to 70 miles | 12 | 785.22 | 2 | 130.33 |
| Over 70 to 80 miles | 7 | 532.46 | 1 | 76.48 |
| Over 80 to 90 miles | 6 | 515.30 | 1 | 84.42 |
| Over 90 to 100 miles | 3 | 277.12 | ..... | ..... |
| Over 100 miles | 25 | 4,349.10 | 2 | 238.65 |

* Operating companies.
† Exclusive of 15 lessor companies.
‡ Exclusive of 663.94 miles estimated in 1890.

COMPARATIVE SUMMARY, ALL COMPANIES: 1890 AND 1902.

| ITEMS. | 1902 | 1890 | Per cent of increase. |
|---|---|---|---|
| Number of companies | 987 | 706 | 39.8 |
| Cost of construction and equipment | $2,167,634,077 | $389,357,289 | 456.7 |
| Capital stock issued | $1,315,572,960 | $289,058,133 | 355.1 |
| Funded debt outstanding | $992,709,139 | $189,177,824 | 424.7 |
| Earnings from operation | $247,553,999 | $90,617,211 | 173.2 |
| Operating expenditures | $142,312,597 | $62,011,185 | 129.5 |
| Percentage operating expenses of earnings | 57.5 | 68.4 | ..... |
| Number of passenger cars | 60,290 | 32,505 | 85.5 |
| Number of fare passengers carried | 4,809,554,438 | 2,023,010,202 | 137.7 |
| Number of employees* | 133,641 | 70,764 | 88.9 |

* Exclusive of salaried officials and clerks.

The "length of line" as given in the report means the length of the road-bed, or, in the case of a railway lying entirely within city limits, the length of street occupied. In determining the length of single track, switches and sidings are included, and double track is reckoned as two tracks. The increase in the length of line during the period of twelve years amounted to 11,532.05 miles, or 225.3 per cent, as compared with an increase of 14,466.45 miles, or 178.1 per cent, in the length of single track. Single-track roads are characteristic of rural districts, and the fact that the percentage of increase in length of line is greater than in length of single track is due principally to the great development of interurban single-track lines since 1890.

The average length of line per operating company in 1890 was 7.41 miles as compared with 20.38 miles in 1902. The average operating com-

RELATION OF STREET AND ELECTRIC RAILWAYS TO POPULATION 1890 AND 1902.

| GEOGRAPHIC DIVISIONS. | Year. | Population.* | Total number of fare passengers carried. | Average number of rides per inhabitant. |
|---|---|---|---|---|
| United States | 1902 | 75,994,575 | 4,809,554,438 | 63 |
| | 1890 | 62,622,250 | 2,023,010,202 | 32 |
| Increase | ..... | 13,372,325 | 2,786,544,236 | 31 |
| North Atlantic | 1902 | 21,046,695 | 2,618,528,979 | 124 |
| | 1890 | 17,401,545 | 1,141,187,460 | 66 |
| Increase | ..... | 3,645,150 | 1,477,341,519 | 58 |
| South Atlantic | 1902 | 10,443,480 | 332,541,075 | 32 |
| | 1890 | 8,857,920 | 101,647,174 | 11 |
| Increase | ..... | 1,585,560 | 230,893,901 | 21 |
| North Central | 1902 | 26,333,004 | 1,344,000,951 | 51 |
| | 1890 | 22,362,279 | 538,309,887 | 24 |
| Increase | ..... | 3,970,725 | 805,691,064 | 27 |
| South Central | 1902 | 14,080,047 | 210,103,861 | 15 |
| | 1890 | 10,972,893 | 98,005,026 | 9 |
| Increase | ..... | 3,107,154 | 112,098,835 | 6 |
| Western | 1902 | 4,091,349 | 304,379,572 | 74 |
| | 1890 | 3,027,613 | 143,860,655 | 48 |
| Increase | ..... | 1,063,736 | 160,518,917 | 26 |

* Population shown for 1902 is that reported at the census of 1900.

pany in 1902 controlled almost three times the length of line that was controlled by the average company in 1890. In 1890 there were only 8 companies operating more than 50 miles of line, and in 1902 the number of such companies had increased to 69. Of the total number of companies reported for 1890, 94.9 per cent operated less than 20 miles of line each, and their combined length of line amounted to 71.5 per cent of the total in the United States; in 1902 corresponding percentages were 75 and 30.7, respectively. Thus, while there are still a large number of companies that operate less than 20 miles of track, the portion of the total length of line operated by them is not half as great as in 1890.

The extent to which street and electric railways are used, and the increase in their use as measured by the average number of rides per inhabitant, are shown below.

From this table it appears that the most extensive use of street and electric railways is in the North Atlantic states, where the average number of rides per inhabitant in 1902 was 124; the Western states come next with an average of 74. The greatest increase in this respect is shown for the South Atlantic states, where the average was almost three times as great in 1902 as it was in 1890.

NUMBER OF OPERATING AND LESSOR COMPANIES BY STATES AND TERRITORIES: 1902.

| States and Territories | Total. | Operating. | States and Territories. | Total. | Operating. |
|---|---|---|---|---|---|
| United States | 987 | 817 | Mississippi | 5 | 5 |
| | | | Missouri | 17 | 16 |
| Alabama | 9 | 9 | Montana | 5 | 5 |
| Arizona | 2 | 2 | Nebraska | 4 | 4 |
| Arkansas | 7 | 7 | New Hampshire | 13 | 7 |
| California | 35 | 35 | New Jersey | 30 | 26 |
| Colorado | 9 | 8 | New Mexico | 1 | 1 |
| Connecticut | 27 | 23 | New York | 119 | 96 |
| Delaware | 3 | 3 | North Carolina | 7 | 7 |
| District of Columbia | 8 | 8 | Ohio | 67 | 63 |
| Florida | 6 | 6 | Oregon | 6 | 6 |
| Georgia | 10 | 10 | Pennsylvania | 196 | 98 |
| Idaho | 1 | 1 | Rhode Island | 8 | 8 |
| Illinois | 58 | 50 | South Carolina | 7 | 7 |
| Indiana | 27 | 27 | South Dakota | 1 | 1 |
| Iowa | 22 | 22 | Tennessee | 8 | 8 |
| Kansas | 12 | 12 | Texas | 17 | 17 |
| Kentucky | 12 | 12 | Utah | 3 | 3 |
| Louisiana | 8 | 8 | Vermont | 9 | 9 |
| Maine | 20 | 19 | Virginia | 21 | 21 |
| Maryland | 12 | 10 | Washington | 8 | 8 |
| Massachusetts | 93 | 75 | West Virginia | 8 | 8 |
| Michigan | 24 | 24 | Wisconsin | 17 | 17 |
| Minnesota | 5 | 5 | | | |

Accidents.—The following statement reproduces the totals concerning the number of persons killed and injured in the United States for the year 1902:

| Persons. | Killed. | Injured. |
|---|---|---|
| Total | 1,218 | 47,429 |
| Passengers | 265 | 26,690 |
| Employees | 122 | 3,699 |
| Others | 831 | 17,040 |

"Others" referred to in this statement, include persons on foot or riding in vehicles other than street cars who were killed or injured in collision with street cars. The number of persons reported as killed, 1,218, and injured, 47,429, form only an inappreciable percentage of the total number of passengers carried.—*From a Bulletin published by the Census Bureau.*

# CHAPTER VI.

## POPULATION OF THE UNITED STATES.

The population of the United States, according to the Twelfth Census, was 75,994,575, divided as follows: 38,816,448 males, 37,178,127 females. Of the total, 65,653,299 were native born, and 10,341,276 foreign born. The population is again divided as follows: White, 66,809,196; negroes, 8,833,994; Indians 237,196, but this figure does not include the population of Indian territory or on Indian reservations: Chinese, 89,863; Japanese, 24,326.

### POPULATION OF EACH STATE AND TERRITORY OF THE UNITED STATES.

| States and Territories. | 1790. | 1800. | 1860. | 1880. | 1890. | 1900. |
|---|---|---|---|---|---|---|
| Alabama | | | 964,201 | 1,262,505 | 1,513,017 | 1,828,697 |
| Alaska | | | | | 32,052 | 63,592 |
| Arizona | | | | 40,440 | 59,620 | 122,931 |
| Arkansas | | | 435,450 | 802,525 | 1,128,179 | 1,311,564 |
| California | | | 379,994 | 864,694 | 1,208,130 | 1,485,053 |
| Colorado | | | 34,277 | 194,327 | 412,198 | 539,700 |
| Connecticut | 237,946 | 251,002 | 460,147 | 622,700 | 746,258 | 908,420 |
| Delaware | 59,096 | 64,273 | 112,216 | 146,608 | 168,493 | 184,735 |
| District of Columbia | | 14,093 | 75,080 | 177,624 | 230,392 | 278,718 |
| Florida | | | 140,424 | 269,493 | 391,422 | 528,542 |
| Georgia | 82,548 | 162,686 | 1,057,286 | 1,542,180 | 1,837,353 | 2,216,331 |
| Idaho | | | | 32,610 | 84,385 | 161,772 |
| Illinois | | | 1,711,951 | 3,077,871 | 3,826,351 | 4,821,550 |
| Indiana | | 5,641 | 1,350,428 | 1,978,301 | 2,192,404 | 2,516,462 |
| Indian Territory | | | | | 180,182 | 392,060 |
| Iowa | | | 674,913 | 1,624,615 | 1,911,896 | 2,231,853 |
| Kansas | | | 107,206 | 996,096 | 1,427,096 | 1,470,495 |
| Kentucky | 73,677 | 220,955 | 1,155,684 | 1,648,690 | 1,858,635 | 2,147,174 |
| Louisiana | | | 708,002 | 939,946 | 1,118,587 | 1,381,625 |
| Maine | 96,540 | 151,719 | 628,279 | 648,936 | 661,086 | 694,466 |
| Maryland | 319,728 | 341,548 | 687,049 | 934,943 | 1,042,390 | 1,188,044 |
| Massachusetts | 378,787 | 422,845 | 1,231,066 | 1,783,085 | 2,238,943 | 2,805,346 |
| Michigan | | | 749,113 | 1,636,937 | 2,093,889 | 2,420,982 |
| Minnesota | | | 172,023 | 780,773 | 1,301,826 | 1,751,394 |
| Mississippi | | 8,850 | 791,305 | 1,131,597 | 1,289,600 | 1,551,270 |
| Missouri | | | 1,182,012 | 2,168,380 | 2,679,184 | 3,106,665 |
| Montana | | | | 39,159 | 132,159 | 243,329 |
| Nebraska | | | 28,841 | 452,402 | 1,058,910 | 1,066,300 |
| Nevada | | | 6,857 | 62,266 | 45,761 | 42,335 |
| New Hampshire | 141,885 | 183,858 | 326,073 | 346,991 | 376,530 | 411,588 |
| New Jersey | 184,139 | 211,149 | 672,035 | 1,131,116 | 1,444,933 | 1,883,669 |
| New Mexico | | | 93,516 | 119,565 | 153,593 | 195,310 |
| New York | 340,120 | 589,051 | 3,880,735 | 5,082,871 | 5,997,853 | 7,268,894 |
| North Carolina | 393,751 | 478,103 | 992,622 | 1,399,550 | 1,617,947 | 1,893,810 |
| North Dakota | | | 4,837 | 135,177 | 182,719 | 319,146 |
| Ohio | | 45,365 | 2,339,511 | 3,198,062 | 3,672,316 | 4,157,545 |
| Oklahoma | | | | | 61,834 | 398,331 |
| Oregon | | | 52,465 | 174,768 | 313,767 | 413,563 |
| Pennsylvania | 434,373 | 602,365 | 2,906,215 | 4,282,891 | 5,258,014 | 6,302,115 |
| Rhode Island | 68,825 | 69,122 | 174,620 | 276,531 | 345,506 | 428,556 |
| South Carolina | 249,073 | 345,591 | 703,708 | 995,577 | 1,151,149 | 1,340,316 |
| South Dakota | | | | | 328,808 | 401,570 |
| Tennessee | 35,691 | 105,602 | 1,109,801 | 1,542,359 | 1,767,518 | 2,020,615 |
| Texas | | | 604,215 | 1,591,749 | 2,235,523 | 3,048,710 |
| Utah | | | 40,273 | 143,963 | 207,905 | 276,749 |

POPULATION OF EACH STATE AND TERRITORY OF THE UNITED STATES—*Continued.*

| States and Territories. | 1790. | 1800. | 1860. | 1880. | 1890. | 1900. |
|---|---|---|---|---|---|---|
| Vermont | 85,425 | 154,465 | 315,098 | 332,286 | 332,422 | 343,641 |
| Virginia | 747,610 | 880,200 | 1,596,318 | 1,512,565 | 1,655,980 | 1,854,184 |
| Washington | ..... | ..... | 11,594 | 75,116 | 349,390 | 518,103 |
| West Virginia | ..... | ..... | ..... | 618,457 | 762,794 | 958,800 |
| Wisconsin | ..... | ..... | 775,881 | 1,315,497 | 1,686,880 | 2,069,042 |
| Wyoming | ..... | ..... | ..... | 20,789 | 60,705 | 92,531 |
| Persons on public ships in the service of the United States or stationed abroad | ..... | ..... | ..... | ..... | ..... | *91,219 |
| Total United States, | 3,929,214 | 5,308,483 | 31,443,321 | 50,155,783 | 62,622,250 | 75,693,734 |
| Alaska | ..... | ..... | ..... | ..... | 32,052 | 63,592 |
| Hawaii | ..... | ..... | ..... | ..... | 89,990 | 154,001 |
| Indian Territory | ..... | ..... | ..... | ..... | 180,182 | 392,060 |
| Indians on Reservations | ..... | ..... | ..... | ..... | 145,282 | (†) |
| Total | ..... | ..... | ..... | ..... | 63,069,756 | 76,303,387 |

* Includes 6,394 negroes

† Included in the population of the several States.

[*From Reports of the Census.*]

The figures of the Bureau of Statistics vary somewhat from those of the Census, and their table given farther on is later than the Census figures. The census of the Philippine Islands taken 1903, gives the population as 7,635,426, of which 647,740 are classified as wild and uncivilized. Luzón contains 3,798,507 persons; Panay has 743,646 people; Mindanao is fourth with 499,634 inhabitants; Joló follows with 44,718 people, of whom only 1,270 are civilized. The population of Manila is 219,928.

## OFFICIAL CENSUS OF THE UNITED STATES, BY COUNTIES, FOR 1900.

### ALABAMA.

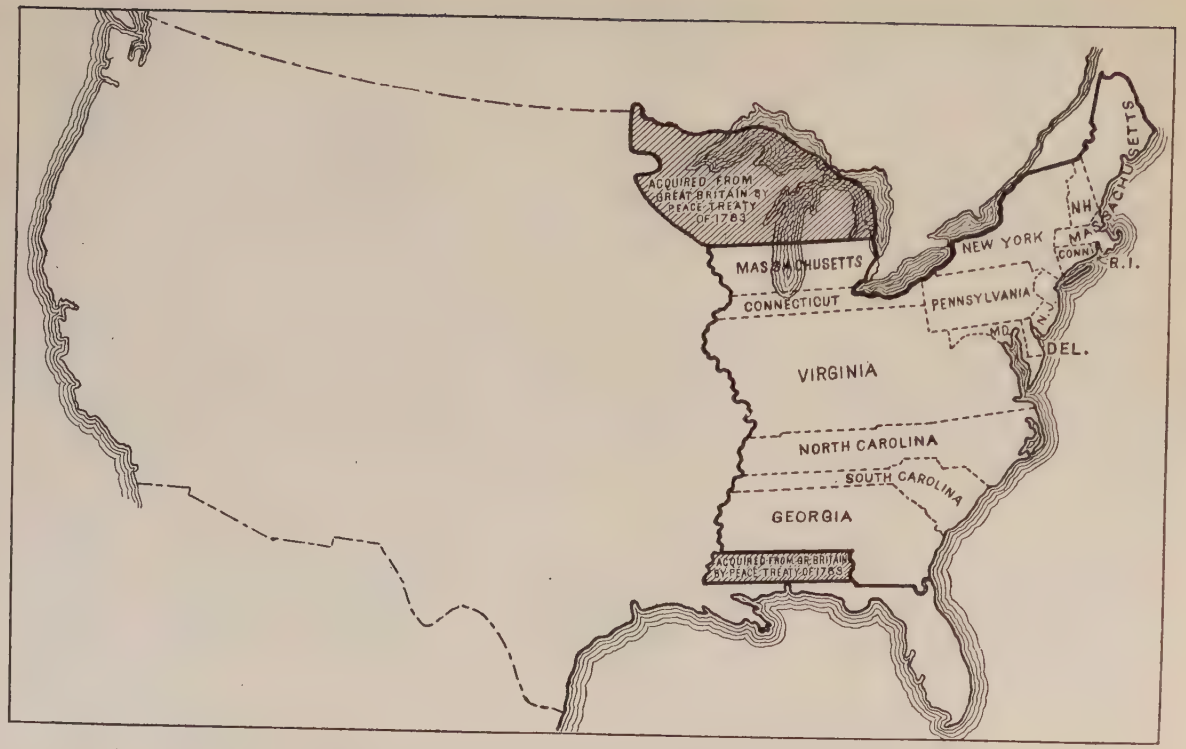
AREA, 50,722 SQUARE MILES.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Autauga | 17,915 | Conecuh | 17,514 | Jackson | 30,508 | Perry | 31,783 |
| Baldwin | 13,194 | Coosa | 16,144 | Jefferson | 140,420 | Pickens | 24,402 |
| Barbour | 35,152 | Covington | 15,346 | Lamar | 16,084 | Pike | 29,172 |
| Bibb | 18,498 | Crenshaw | 19,668 | Lauderdale | 26,559 | Randolph | 21,647 |
| Blount | 23,119 | Cullman | 17,849 | Lawrence | 20,124 | Russell | 27,083 |
| Bullock | 31,944 | Dale | 21,189 | Lee | 31,826 | St. Clair | 19,425 |
| Butler | 25,761 | Dallas | 54,657 | Limestone | 22,387 | Shelby | 23,684 |
| Calhoun | 34,874 | Dekalb | 23,558 | Lowndes | 35,651 | Sumter | 32,710 |
| Chambers | 32,554 | Elmore | 26,099 | Macon | 23,126 | Talladega | 35,773 |
| Cherokee | 21,096 | Escambia | 11,320 | Madison | 43,702 | Tallapoosa | 29,675 |
| Chilton | 16,522 | Etowah | 27,361 | Marengo | 38,315 | Tuscaloosa | 36,147 |
| Choctaw | 18,136 | Fayette | 14,132 | Marion | 14,494 | Walker | 25,162 |
| Clarke | 27,790 | Franklin | 16,511 | Marshall | 23,289 | Washington | 11,134 |
| Clay | 17,099 | Geneva | 19,096 | Mobile | 62,740 | Wilcox | 35,631 |
| Cleburne | 13,206 | Greene | 24,182 | Monroe | 23,666 | Winston | 9,554 |
| Coffee | 20,972 | Hale | 31,011 | Montgomery | 72,047 | | |
| Colbert | 22,341 | Henry | 36,147 | Morgan | 28,820 | | |
| Total | | | | | | | 1,828,697 |

### ARIZONA.

AREA, 113,916 SQUARE MILES.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Apache | 8,297 | Graham | 14,162 | Pima | 14,689 | Yuma | 4,145 |
| Cochise | 9,251 | Maricopa | 20,457 | Pinal | 7,779 | San Carlos Indian Reserv'n. | 3,065 |
| Coconino | 5,514 | Mohave | 3,426 | Santa Cruz | 4,545 | | |
| Gila | 4,973 | Navajo | 8,829 | Yavapai | 13,799 | | |
| Total | | | | | | | 122,931 |




THE THIRTEEN ORIGINAL STATES, WITH THE ACCESSIONS OF TERRITORY GRANTED BY THE TREATY OF 1783 WITH GREAT BRITAIN.

## ARKANSAS.

AREA, 52,198 SQUARE MILES.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Arkansas | 12,973 | Dallas | 11,518 | Lee | 19,409 | Pope | 21,715 |
| Ashley | 19,734 | Desha | 11,511 | Lincoln | 13,389 | Prairie | 11,875 |
| Baxter | 9,298 | Drew | 19,451 | Little River | 13,731 | Pulaski | 63,179 |
| Benton | 31,611 | Faulkner | 20,780 | Logan | 20,563 | Randolph | 17,156 |
| Boone | 16,396 | Franklin | 17,395 | Lonoke | 22,544 | St. Francis | 17,157 |
| Bradley | 9,651 | Fulton | 12,917 | Madison | 19,864 | Saline | 13,122 |
| Calhoun | 8,539 | Garland | 18,773 | Marion | 11,377 | Scott | 13,183 |
| Carroll | 18,848 | Grant | 7,671 | Miller | 17,558 | Searcy | 11,988 |
| Chicot | 14,528 | Greene | 16,979 | Mississippi | 16,384 | Sebastian | 36 935 |
| Clark | 21,289 | Hempstead | 24,101 | Monroe | 16,816 | Sevier | 16,339 |
| Clay | 15,886 | Hot Spring | 12,748 | Montgomery | 9,444 | Sharp | 12,199 |
| Cleburne | 9,628 | Howard | 14,076 | Nevada | 16,609 | Stone | 8,100 |
| Cleveland | 11,620 | Independence | 22,557 | Newton | 12,538 | Union | 22,495 |
| Columbia | 22,077 | Izard | 13,506 | Ouachita | 20.892 | Van Buren | 11.220 |
| Conway | 19,772 | Jackson | 18,383 | Perry | 7,294 | Washington | 34,256 |
| Craighead | 19,505 | Jefferson | 40,972 | Phillips | 26,561 | White | 24.864 |
| Crawford | 21,270 | Johnson | 17,448 | Pike | 10,301 | Woodruff | 16.304 |
| Crittenden | 14,529 | Lafayette | 10,594 | Poinsett | 7,025 | Yell | 22,750 |
| Cross | 11,051 | Lawrence | 16,491 | Polk | 18,352 | | |

Total ..... 1,311,564

## CALIFORNIA.

AREA, 188,981 SQUARE MILES.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Alameda | 130,197 | Lake | 6,017 | Plumas | 4,657 | Shasta | 17,318 |
| Alpine | 509 | Lassen | 4,511 | Riverside | 17,897 | Sierra | 4,017 |
| Amador | 11,116 | Los Angeles | 170,298 | Sacramento | 45,915 | Siskiyou | 16,962 |
| Butte | 17,117 | Madera | 6,364 | San Benito | 6,633 | Solano | 24,143 |
| Calaveras | 11,200 | Marin | 15,702 | San Bernardino | 27,929 | Sonoma | 38,480 |
| Colusa | 7,364 | Mariposa | 4,720 | San Diego | 35,090 | Stanislaus | 9,550 |
| Contra Costa | 18,046 | Mendocino | 20,465 | San Francisco | 342,782 | Sutter | 5,885 |
| Del Norte | 2,408 | Merced | 9,215 | San Joaquin | 35,452 | Tehama | 10,996 |
| Eldorado | 8,986 | Modoc | 5,076 | San Luis Obispo | 16,637 | Trinity | 4,383 |
| Fresno | 37,862 | Mono | 2,167 | San Mateo | 12,094 | Tulare | 18,375 |
| Glenn | 5,150 | Monterey | 19,380 | Santa Barbara | 18,934 | Tuolumne | 11,166 |
| Humboldt | 27,104 | Napa | 16,451 | Santa Clara | 60,216 | Ventura | 14,367 |
| Inyo | 4,377 | Nevada | 17,789 | Santa Cruz | 21,512 | Yolo | 13,618 |
| Kern | 16,480 | Orange | 19,696 | | | Yuba | 8,620 |
| Kings | 9,871 | Placer | 15,786 | | | | |

Total ..... 1,485,053

## COLORADO.

AREA, 104,500 SQUARE MILES.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Arapahoe | 153,017 | Elbert | 3,101 | Las Animas | 21,840 | Rio Blanco | 1,690 |
| Archuleta | 2,117 | El Paso | 31,602 | Lincoln | 926 | Rio Grande | 4,080 |
| Baca | 759 | Fremont | 15,636 | Logan | 3,292 | Routt | 3,661 |
| Bent | 3,049 | Garfield | 5,835 | Mesa | 9,267 | Saguache | 3,853 |
| Boulder | 21,544 | Gilpin | 6,690 | Mineral | 1,913 | San Juan | 2,342 |
| Chaffee | 7,085 | Grand | 741 | Montezuma | 3,058 | San Miguel | 5,379 |
| Cheyenne | 501 | Gunnison | 5,331 | Montrose | 4,535 | Sedgwick | 971 |
| Clear Creek | 7,082 | Hinsdale | 1,609 | Morgan | 3,268 | Summit | 2,744 |
| Conejos | 8,794 | Huerfano | 8,395 | Otero | 11,522 | Teller | 29,002 |
| Costilla | 4,632 | Jefferson | 9,306 | Ouray | 4,731 | Washington | 1,241 |
| Custer | 2,937 | Kiowa | 701 | Park | 2,998 | Weld | 16,808 |
| Delta | 5,487 | Kit Carson | 1,580 | Phillips | 1,583 | Yuma | 1,729 |
| Dolores | 1,134 | Lake | 18,054 | Pitkin | 7,020 | | |
| Douglas | 3,120 | La Plata | 7,016 | Prowers | 3,766 | | |
| Eagle | 3,008 | Larimer | 12,168 | Pueblo | 34,448 | | |

Total ..... 539,700

## CONNECTICUT.

AREA, 4,674 SQUARE MILES.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Fairfield | 184,203 | Litchfield | 63,672 | New Haven | 269,163 | Tolland | 24,523 |
| Hartford | 195,415 | Middlesex | 41,760 | New London | 82,758 | Windham | 46,861 |

Total ..... 908,355

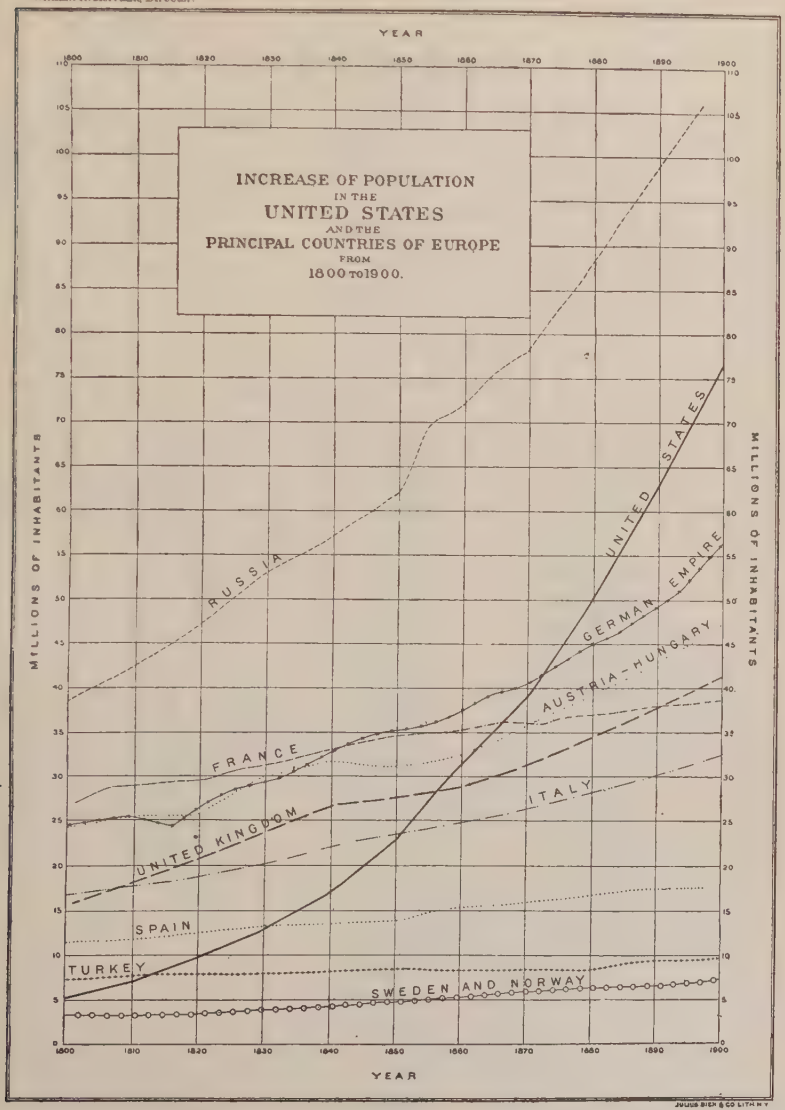
## DELAWARE.

AREA, 2,120 SQUARE MILES.

| | | | | | |
|---|---|---|---|---|---|
| Kent | 32,762 | Newcastle | 109,697 | Sussex | 42,276 |

Total ..... 184,735

Twelfth Census of the United States
William R. Merriam, Director.



## DISTRICT OF COLUMBIA.

AREA, 60 SQUARE MILES.

| | |
|---|---|
| The District | 278,718 |

## FLORIDA.

AREA, 59,268 SQUARE MILES.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Alachua | 32,245 | Franklin | 4,890 | Levy | 8,603 | St. John | 9,165 |
| Baker | 4,516 | Gadsden | 15,294 | Liberty | 2,956 | Santa Rosa | 10,293 |
| Bradford | 10,295 | Hamilton | 11,881 | Madison | 15,446 | Sumter | 6,187 |
| Brevard | 5,158 | Hernando | 3,638 | Manatee | 4,663 | Suwanee | 14,554 |
| Calhoun | 5,132 | Hillsboro | 36,013 | Marion | 24,403 | Taylor | 3,999 |
| Citrus | 5,391 | Holmes | 7,762 | Monroe | 18,006 | Volusia | 10,003 |
| Clay | 5,635 | Jackson | 23,377 | Nassau | 9,654 | Wakulla | 5,149 |
| Columbia | 17,094 | Jefferson | 16,195 | Orange | 11,374 | Walton | 9,346 |
| Dade | 4,955 | Lafayette | 4,987 | Osceola | 3,444 | Washingon | 10,154 |
| De Soto | 8,047 | Lake | 7,467 | Pasco | 6,054 | | |
| Duval | 39,733 | Lee | 3,071 | Polk | 12,472 | | |
| Escambia | 28,313 | Leon | 19,887 | Putnam | 11,641 | | |
| Total | | | | | | | 528,542 |

## GEORGIA.

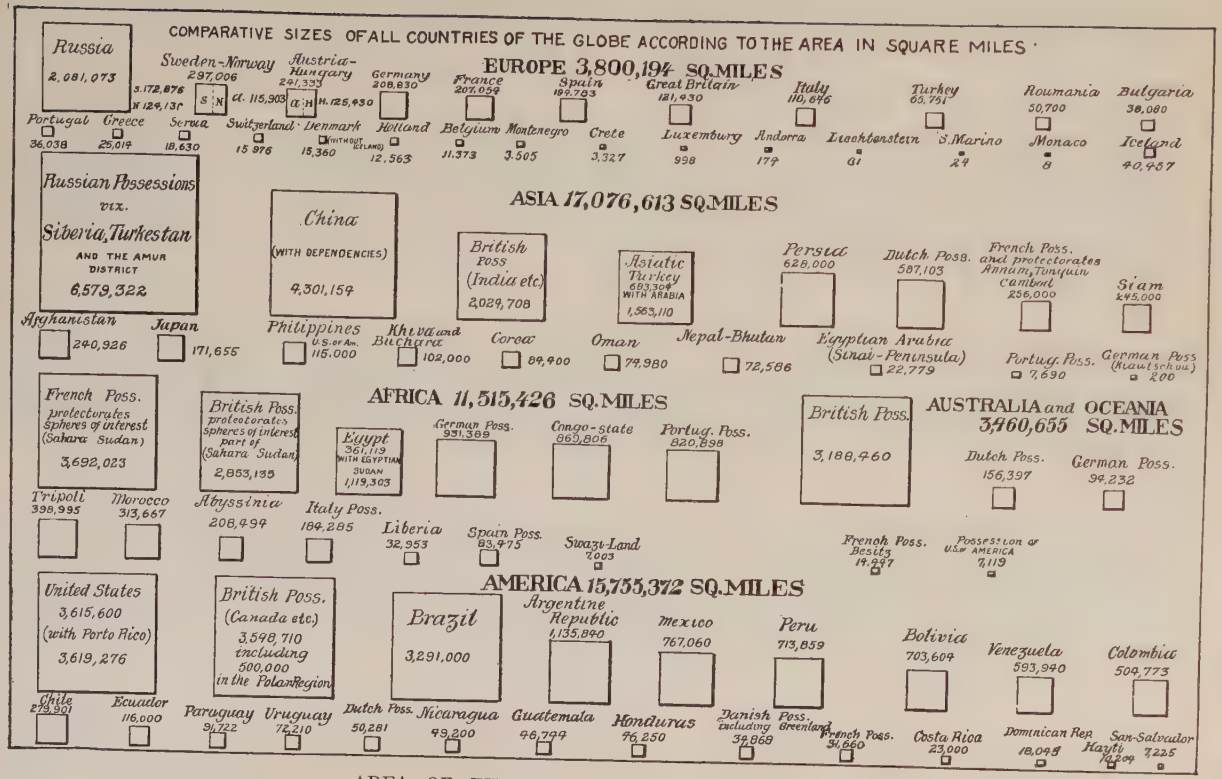
AREA, 58,000 SQUARE MILES.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Appling | 12,336 | Dekalb | 21,112 | Johnson | 11,409 | Richmond | 53,735 |
| Baker | 6,704 | Dodge | 13,975 | Jones | 13,358 | Rockdale | 7,515 |
| Baldwin | 17,768 | Dooly | 26,567 | Laurens | 25,908 | Schley | 5,499 |
| Banks | 10,545 | Dougherty | 13,679 | Lee | 10,344 | Screven | 19,252 |
| Bartow | 20,823 | Douglas | 8,745 | Liberty | 13,093 | Spalding | 17,619 |
| Berrien | 19,440 | Early | 14,828 | Lincoln | 7,156 | Stewart | 15,856 |
| Bibb | 50,473 | Echols | 3,209 | Lowndes | 20,036 | Sumter | 26,212 |
| Brooks | 18,606 | Effingham | 8,334 | Lumpkin | 7,433 | Talbot | 12,197 |
| Bryan | 6,122 | Elbert | 19,729 | McDuffie | 9,804 | Taliaferro | 7,912 |
| Bulloch | 21,377 | Emanuel | 21,279 | McIntosh | 6,537 | Tattnall | 20,419 |
| Burke | 30,165 | Fannin | 11,214 | Macon | 14,093 | Taylor | 9,846 |
| Butts | 12,805 | Fayette | 10,114 | Madison | 13,224 | Telfair | 10,083 |
| Calhoun | 9,274 | Floyd | 33,113 | Marion | 10,080 | Terrell | 19,023 |
| Camden | 7,669 | Forsyth | 11,550 | Meriwether | 23,339 | Thomas | 31,076 |
| Campbell | 9,518 | Franklin | 17,700 | Miller | 6,319 | Towns | 4,748 |
| Carroll | 26,576 | Fulton | 117,363 | Milton | 6,763 | Troup | 24,002 |
| Catoosa | 5,823 | Gilmer | 10,198 | Mitchell | 14,767 | Twiggs | 8,716 |
| Charlton | 3,592 | Glascock | 4,516 | Monroe | 20,682 | Union | 8,481 |
| Chatham | 71,239 | Glynn | 14,317 | Montgomery | 16,359 | Upson | 13,670 |
| Chattahoochee | 5,790 | Gordon | 14,119 | Morgan | 15,813 | Walker | 15,661 |
| Chattooga | 12,952 | Greene | 16,542 | Murray | 8,623 | Walton | 20,942 |
| Cherokee | 15,243 | Gwinnett | 25,585 | Muscogee | 29,836 | Ware | 13,761 |
| Clarke | 17,708 | Habersham | 13,604 | Newton | 16,734 | Warren | 11,463 |
| Clay | 8,568 | Hall | 20,752 | Oconee | 8,602 | Washington | 28,227 |
| Clayton | 9,598 | Hancock | 18,277 | Oglethorpe | 17,881 | Wayne | 9,449 |
| Clinch | 8,732 | Haralson | 11,922 | Paulding | 12,969 | Webster | 6,618 |
| Cobb | 24,664 | Harris | 18,009 | Pickens | 8,641 | White | 5,912 |
| Coffee | 16,169 | Hart | 14,492 | Pierce | 8,100 | Whitfield | 14,509 |
| Colquitt | 13,636 | Heard | 11,177 | Pike | 18,761 | Wilcox | 11,097 |
| Columbia | 10,653 | Henry | 18,602 | Polk | 17,856 | Wilkes | 20,866 |
| Coweta | 24,980 | Houston | 22,641 | Pulaski | 18,489 | Wilkinson | 11,440 |
| Crawford | 10,368 | Irwin | 13,645 | Putnam | 13,436 | Worth | 18,664 |
| Dade | 4,578 | Jackson | 24,039 | Quitman | 4,701 | | |
| Dawson | 5,442 | Jasper | 15,033 | Rabun | 6,285 | | |
| Decatur | 29,454 | Jefferson | 18,212 | Randolph | 16,847 | | |
| Total | | | | | | | 2,216,331 |

## IDAHO.

AREA, 86,294 SQUARE MILES.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Ada | 11,559 | Canyon | 7,497 | Kootenai | 10,216 | Owyhee | 3,804 |
| Bannock | 11,702 | Cassia | 3,951 | Latah | 13,451 | Shoshone | 11,950 |
| Bear Lake | 7,051 | Custer | 2,049 | Lemhi | 3,446 | Washington | 6,882 |
| Bingham | 10,447 | Elmore | 2,286 | Lincoln | 1,784 | | |
| Blaine | 4,900 | Fremont | 12,821 | Nez Perces | 13,748 | | |
| Boise | 4,174 | Idaho | 9,121 | Oneida | 8,933 | | |
| Total | | | | | | | 161,772 |




AREA OF THE COUNTRIES OF THE WORLD.

## ILLINOIS.

AREA, 55,405 SQUARE MILES.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Adams | 67,058 | Ford | 18,359 | Livingston | 42,035 | Randolph | 28,001 |
| Alexander | 19,384 | Franklin | 19,675 | Logan | 28,680 | Richland | 16,391 |
| Bond | 16,078 | Fulton | 46,201 | McDonough | 28,412 | Rock Island | 55,249 |
| Boone | 15,791 | Gallatin | 15,836 | McHenry | 29,759 | St. Clair | 86,685 |
| Brown | 11,557 | Greene | 23,402 | McLean | 67,843 | Saline | 21,685 |
| Bureau | 41,112 | Grundy | 24,136 | Macon | 44,003 | Sangamon | 71,593 |
| Calhoun | 8,917 | Hamilton | 20,197 | Macoupin | 42,256 | Schuyler | 16,129 |
| Carroll | 18,963 | Hancock | 32,215 | Madison | 64,694 | Scott | 10,455 |
| Cass | 17,222 | Hardin | 7,448 | Marion | 30,446 | Shelby | 32,126 |
| Champaign | 47,622 | Henderson | 10,836 | Marshall | 16,370 | Stark | 10,186 |
| Christian | 32,790 | Henry | 40,049 | Mason | 17,491 | Stephenson | 34,933 |
| Clark | 24,033 | Iroquois | 38,014 | Massac | 13,110 | Tazewell | 33,221 |
| Clay | 19,553 | Jackson | 33,871 | Menard | 14,336 | Union | 22,610 |
| Clinton | 19,824 | Jasper | 20,160 | Mercer | 20,945 | Vermilion | 65,635 |
| Coles | 34,146 | Jefferson | 28,133 | Monroe | 13,847 | Wabash | 12,583 |
| Cook | 1,838,735 | Jersey | 14,612 | Montgomery | 30,836 | Warren | 23,163 |
| Crawford | 19,240 | Jo Daviess | 24,533 | Morgan | 35,006 | Washington | 19,526 |
| Cumberland | 16,124 | Johnson | 15,667 | Moultrie | 15,224 | Wayne | 27,626 |
| Dekalb | 31,756 | Kane | 78,792 | Ogle | 29,129 | White | 25,386 |
| Dewitt | 18,972 | Kankakee | 37,154 | Peoria | 88,608 | Whiteside | 34,710 |
| Douglas | 19,097 | Kendall | 11,467 | Perry | 19,830 | Will | 74,764 |
| Dupage | 28,196 | Knox | 43,612 | Piatt | 17,706 | Williamson | 27,796 |
| Edgar | 28,273 | Lake | 34,504 | Pike | 31,595 | Winnebago | 47,845 |
| Edwards | 10,345 | Lasalle | 87,776 | Pope | 13,585 | Woodford | 21,822 |
| Effingham | 20,465 | Lawrence | 16,523 | Pulaski | 14,554 | | |
| Fayette | 28,065 | Lee | 29,894 | Putnam | 4,746 | | |
| Total | | | | | | | 4,821,550 |

## INDIANA.

AREA, 33,809 SQUARE MILES.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Adams | 22,232 | Franklin | 16,388 | Lawrence | 25,729 | Rush | 20,148 |
| Allen | 77,270 | Fulton | 17,453 | Madison | 70,470 | St. Joseph | 58,881 |
| Bartholomew | 24,594 | Gibson | 30,099 | Marion | 197,227 | Scott | 8,307 |
| Benton | 13,123 | Grant | 54,693 | Marshall | 25,119 | Shelby | 26,491 |
| Blackford | 17,213 | Greene | 28,530 | Martin | 14,711 | Spencer | 22,407 |
| Boone | 26,321 | Hamilton | 29,914 | Miami | 28,344 | Starke | 10,431 |
| Brown | 9,727 | Hancock | 19,189 | Monroe | 20,873 | Steuben | 15,219 |
| Carroll | 19,953 | Harrison | 21,702 | Montgomery | 29,388 | Sullivan | 26,005 |
| Cass | 34,545 | Hendricks | 21,292 | Morgan | 20,457 | Switzerland | 11,840 |
| Clark | 31,835 | Henry | 25,088 | Newton | 10,448 | Tippecanoe | 38,659 |
| Clay | 34,285 | Howard | 28,575 | Noble | 23,533 | Tipton | 19,116 |
| Clinton | 28,202 | Huntington | 28,901 | Ohio | 4,724 | Union | 6,748 |
| Crawford | 13,476 | Jackson | 26,633 | Orange | 16,854 | Vanderburg | 71,769 |
| Daviess | 29,914 | Jasper | 14,292 | Owen | 15,149 | Vermilion | 15,252 |
| Dearborn | 22,194 | Jay | 26,818 | Parke | 23,000 | Vigo | 62,035 |
| Decatur | 19,518 | Jefferson | 22,913 | Perry | 18,778 | Wabash | 28,235 |
| Dekalb | 25,711 | Jennings | 15,757 | Pike | 20,486 | Warren | 11,371 |
| Delaware | 49,624 | Johnson | 20,223 | Porter | 19,175 | Warrick | 22,329 |
| Dubois | 20,357 | Knox | 32,746 | Posey | 22,333 | Washington | 19,409 |
| Elkhart | 45,052 | Kosciusko | 29,109 | Pulaski | 14,033 | Wayne | 38,970 |
| Fayette | 13,495 | Lagrange | 15,284 | Putnam | 21,478 | Wells | 23,449 |
| Floyd | 30,118 | Lake | 37,892 | Randolph | 28,653 | White | 19,138 |
| Fountain | 21,446 | Laporte | 38,386 | Ripley | 19,881 | Whitley | 17,328 |
| Total | | | | | | | 2,516,492 |

## IOWA.

AREA, 50,914 SQUARE MILES.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Adair | 16,192 | Calhoun | 18,569 | Dallas | 23,058 | Greene | 17,820 |
| Adams | 13,601 | Carroll | 20,319 | Davis | 15,620 | Grundy | 13,757 |
| Allamakee | 18,711 | Cass | 21,274 | Decatur | 18,115 | Guthrie | 18,729 |
| Appanoose | 25,927 | Cedar | 19,371 | Delaware | 19,185 | Hamilton | 19,514 |
| Audubon | 13,626 | Cerro Gordo | 20,672 | Des Moines | 35,989 | Hancock | 13,752 |
| Benton | 25,177 | Cherokee | 16,570 | Dickinson | 7,995 | Hardin | 22,794 |
| Blackhawk | 32,399 | Chickasaw | 17,037 | Dubuque | 56,403 | Harrison | 25,597 |
| Boone | 28,200 | Clarke | 12,440 | Emmet | 9,936 | Henry | 20,022 |
| Bremer | 16,305 | Clay | 13,401 | Fayette | 29,845 | Howard | 14,512 |
| Buchanan | 21,427 | Clayton | 27,750 | Floyd | 17,754 | Humboldt | 12,667 |
| Buena Vista | 16,975 | Clinton | 43,832 | Franklin | 14,996 | Ida | 12,327 |
| Butler | 17,955 | Crawford | 21,685 | Fremont | 18,546 | Iowa | 19,544 |

IOWA—*Continued.*

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Jackson | 23,615 | Mahaska | 34,273 | Plymouth | 22,209 | Union | 19,928 |
| Jasper | 26,976 | Marion | 24,159 | Pocahontas | 15,339 | Van Buren | 17,354 |
| Jefferson | 17,437 | Marshall | 29,991 | Polk | 82,624 | Wapello | 35,426 |
| Johnson | 24,817 | Mills | 16,764 | Pottawattamie | 54,336 | Warren | 20,376 |
| Jones | 21,954 | Mitchell | 14,916 | Poweshiek | 19,414 | Washington | 20,718 |
| Keokuk | 24,979 | Monona | 17,980 | Ringgold | 15,325 | Wayne | 17,491 |
| Kossuth | 22,720 | Monroe | 17,985 | Sac | 17,639 | Webster | 31,757 |
| Lee | 39,719 | Montgomery | 17,803 | Scott | 51,558 | Winnebago | 12,725 |
| Linn | 55,392 | Muscatine | 28,242 | Shelby | 17,932 | Winneshiek | 23,731 |
| Louisa | 13,516 | O'Brien | 16,985 | Sioux | 23,337 | Woodbury | 54,610 |
| Lucas | 16,126 | Osceola | 8,725 | Story | 23,159 | Worth | 10,887 |
| Lyon | 13,165 | Page | 24,187 | Tama | 24,585 | Wright | 18,227 |
| Madison | 17,710 | Palo Alto | 14,354 | Taylor | 18,784 | | |
| Total | | | | | | | 2,231,853 |

KANSAS.

AREA, 78,418 SQUARE MILES.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Allen | 19,507 | Finney | 3,469 | Logan | 1,962 | Rooks | 7,960 |
| Anderson | 13,938 | Ford | 5,497 | Lyon | 25,074 | Rush | 6,134 |
| Atchison | 28,606 | Franklin | 21,354 | McPherson | 21,421 | Russell | 8,489 |
| Barber | 6,594 | Geary | 10,744 | Marion | 20,676 | Saline | 17,076 |
| Barton | 13,784 | Gove | 2,441 | Marshall | 24,355 | Scott | 1,098 |
| Bourbon | 24,712 | Graham | 5,173 | Meade | 1,581 | Sedgwick | 44,037 |
| Brown | 22,369 | Grant | 422 | Miami | 21,641 | Seward | 822 |
| Butler | 23,363 | Gray | 1,264 | Mitchell | 14,647 | Shawnee | 53,727 |
| Chase | 8,246 | Greeley | 493 | Montgomery | 29,039 | Sheridan | 3,819 |
| Chautauqua | 11,804 | Greenwood | 16,196 | Morris | 11,967 | Sherman | 3,341 |
| Cherokee | 42,694 | Hamilton | 1,426 | Morton | 304 | Smith | 16,384 |
| Cheyenne | 2,640 | Harper | 10,310 | Nemaha | 20,376 | Stafford | 9,829 |
| Clark | 1,701 | Harvey | 17,591 | Neosho | 19,254 | Stanton | 327 |
| Clay | 15,833 | Haskell | 457 | Ness | 4,535 | Stevens | 620 |
| Cloud | 18,071 | Hodgeman | 2,032 | Norton | 11,325 | Sumner | 25,631 |
| Coffey | 16,643 | Jackson | 17,171 | Osage | 23,659 | Thomas | 4,112 |
| Comanche | 1,619 | Jefferson | 17,533 | Osborne | 11,844 | Trego | 2,722 |
| Cowley | 30,156 | Jewell | 19,420 | Ottawa | 11,182 | Wabaunsee | 12,813 |
| Crawford | 38,809 | Johnson | 18,104 | Pawnee | 5,084 | Wallace | 1,178 |
| Decatur | 9,234 | Kearny | 1,107 | Phillips | 14,442 | Washington | 21,963 |
| Dickinson | 21,816 | Kingman | 10,663 | Pottawatomie | 18,470 | Wichita | 1,197 |
| Doniphan | 15,079 | Kiowa | 2,365 | Pratt | 7,085 | Wilson | 15,621 |
| Douglas | 25,096 | Labette | 27,387 | Rawlins | 5,241 | Woodson | 10,022 |
| Edwards | 3,682 | Lane | 1,563 | Reno | 29,027 | Wyandotte | 73,227 |
| Elk | 11,443 | Leavenworth | 40,940 | Republic | 18,248 | | |
| Ellis | 8,626 | Lincoln | 9,886 | Rice | 14,745 | | |
| Ellsworth | 9,626 | Linn | 16,689 | Riley | 13,828 | | |
| Total | | | | | | | 1,470,495 |

KENTUCKY.

AREA, 37,680 SQUARE MILES.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Adair | 14,888 | Casey | 15,144 | Greenup | 15,432 | Letcher | 9,172 |
| Allen | 14,657 | Christian | 37,962 | Hancock | 8,914 | Lewis | 17,868 |
| Anderson | 10,051 | Clark | 16,694 | Hardin | 22,937 | Lincoln | 17,059 |
| Ballard | 10,761 | Clay | 15,364 | Harlan | 9,838 | Livingston | 11,354 |
| Barren | 23,197 | Clinton | 7,871 | Harrison | 18,570 | Logan | 25,994 |
| Bath | 14,734 | Crittenden | 15,191 | Hart | 18,390 | Lyon | 9,319 |
| Bell | 15,701 | Cumberland | 8,962 | Henderson | 32,907 | McCracken | 28,733 |
| Boone | 11,170 | Daviess | 38,667 | Henry | 14,620 | McLean | 12,448 |
| Bourbon | 18,069 | Edmonson | 10,080 | Hickman | 11,745 | Madison | 25,607 |
| Boyd | 18,834 | Elliott | 10,387 | Hopkins | 30,995 | Magoffin | 12,006 |
| Boyle | 13,817 | Estill | 11,669 | Jackson | 10,561 | Marion | 16,290 |
| Bracken | 12,137 | Fayette | 42,071 | Jefferson | 232,549 | Marshall | 13,692 |
| Breathitt | 14,322 | Fleming | 17,074 | Jessamine | 11,925 | Martin | 5,780 |
| Breckinridge | 20,534 | Floyd | 15,552 | Johnson | 13,730 | Mason | 20,446 |
| Bullitt | 9,602 | Franklin | 20,852 | Kenton | 63,591 | Meade | 10,533 |
| Butler | 15,896 | Fulton | 11,546 | Knott | 8,704 | Menifee | 6,818 |
| Caldwell | 14,510 | Gallatin | 5,163 | Knox | 17,372 | Mercer | 14,426 |
| Calloway | 17,633 | Garrard | 12,042 | Larue | 10,764 | Metcalfe | 9,978 |
| Campbell | 54,223 | Grant | 13,239 | Laurel | 17,592 | Monroe | 13,053 |
| Carlisle | 10,195 | Graves | 33,204 | Lawrence | 19,612 | Montgomery | 12,034 |
| Carroll | 9,825 | Grayson | 19,878 | Lee | 7,988 | Morgan | 12,792 |
| Carter | 20,228 | Green | 12,255 | Leslie | 6,753 | Muhlenberg | 20,741 |

KENTUCKY—*Continued.*

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Nelson | 16,587 | Pike | 22,686 | Shelby | 18,340 | Warren | 29,970 |
| Nicholas | 11,952 | Powell | 6,443 | Simpson | 11,624 | Washington | 14,182 |
| Ohio | 27,287 | Pulaski | 31,293 | Spencer | 7,406 | Wayne | 14,892 |
| Oldham | 7,078 | Robertson | 4,900 | Taylor | 11,075 | Webster | 20,097 |
| Owen | 17,553 | Rockcastle | 12,416 | Todd | 17,371 | Whitley | 25,015 |
| Owsley | 6,874 | Rowan | 8,277 | Trigg | 14,073 | Wolfe | 8,764 |
| Pendleton | 14,947 | Russell | 9,695 | Trimble | 7,272 | Woodford | 13,134 |
| Perry | 8,276 | Scott | 18,076 | Union | 21,326 | | |

Total ..... 2,147,174

LOUISIANA.

AREA, 41,255 SQUARE MILES.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Acadia | 23,483 | East Carroll | 11,373 | Ouachita | 20,947 | St. Tammany | 13,335 |
| Ascension | 24,142 | East Feliciana | 20,443 | Plaquemines | 13,039 | Tangipahoa | 17,625 |
| Assumption | 21,620 | Franklin | 8,890 | Pointe Coupee | 25,777 | Tensas | 19,070 |
| Avoyelles | 29,701 | Grant | 12,902 | Rapides | 39,578 | Terrebonne | 24,464 |
| Bienville | 17,588 | Iberia | 29,015 | Red River | 11,548 | Union | 18,521 |
| Bossier | 24,153 | Iberville | 27,006 | Richland | 11,116 | Vermilion | 20,705 |
| Caddo | 44,499 | Jackson | 9,119 | Sabine | 15,421 | Vernon | 10,327 |
| Calcasieu | 30,428 | Jefferson | 15,321 | St. Bernard | 5,031 | Washington | 9,628 |
| Caldwell | 6,917 | Lafayette | 22,825 | St. Charles | 9,072 | Webster | 15,125 |
| Cameron | 3,952 | Lafourche | 28,882 | St. Helena | 8,479 | West Baton Rouge | 10,285 |
| Catahoula | 16,351 | Lincoln | 15,898 | St. James | 20,197 | West Carroll | 3,685 |
| Claiborne | 23,029 | Livingston | 8,100 | St. John the Baptist | 12,330 | West Feliciana | 15,994 |
| Concordia | 13,559 | Madison | 12,322 | St. Landry | 52,906 | Winn | 9,648 |
| De Soto | 25,063 | Morehouse | 16,634 | St. Martin | 18,940 | | |
| East Baton Rouge | 31,153 | Natchitoches | 33,216 | St. Mary | 34,145 | | |
| | | Orleans | 287,104 | | | | |

Total ..... 1,381,625

MAINE.

AREA, 31,766 SQUARE MILES.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Androscoggin | 54,242 | Hancock | 37,241 | Oxford | 32,238 | Somerset | 33,849 |
| Aroostook | 60,744 | Kennebec | 59,117 | Penobscot | 76,246 | Waldo | 24,185 |
| Cumberland | 100,689 | Knox | 30,406 | Piscataquis | 16,949 | Washington | 45,232 |
| Franklin | 18,444 | Lincoln | 19,669 | Sagadahoc | 20,330 | York | 64,885 |

Total ..... 694,466

MARYLAND.

AREA, 11,124 SQUARE MILES.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Allegany | 53,694 | Carroll | 33,860 | Harford | 28,269 | St. Mary | 18,136 |
| Anne Arundel | 40,018 | Cecil | 24,662 | Howard | 16,715 | Somerset | 25,923 |
| Baltimore | 90,755 | Charles | 18,316 | Kent | 18,786 | Talbot | 20,342 |
| Baltimore City | 508,957 | Dorchester | 27,962 | Montgomery | 30,451 | Washington | 45,133 |
| Calvert | 10,223 | Frederick | 51,920 | Prince George | 29,898 | Wicomico | 22,852 |
| Caroline | 16,248 | Garrett | 17,701 | Queen Anne | 18,364 | Worcester | 20,865 |

Total ..... 1,188,044

MASSACHUSETTS.

AREA, 7,800 SQUARE MILES.

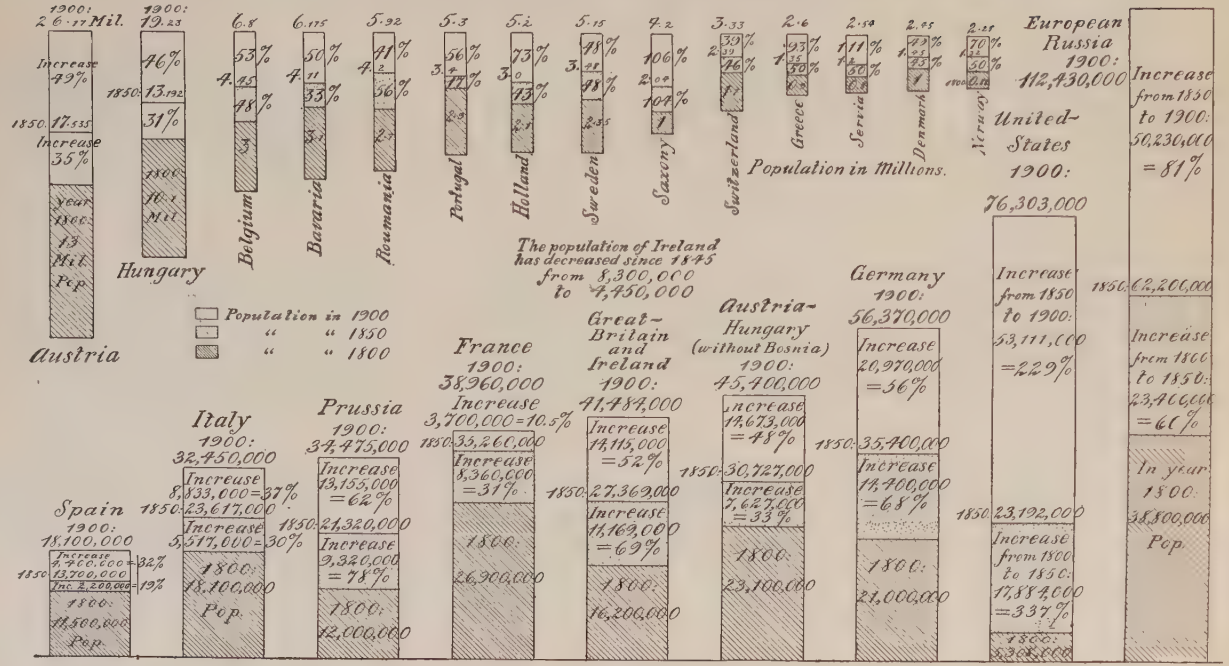
| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Barnstable | 27,826 | Essex | 357,030 | Middlesex | 565,696 | Suffolk | 611,417 |
| Berkshire | 95,667 | Franklin | 41,209 | Nantucket | 3,006 | Worcester | 346,958 |
| Bristol | 252,029 | Hampden | 175,603 | Norfolk | 151,539 | | |
| Dukes | 4,561 | Hampshire | 58,820 | Plymouth | 113,985 | | |

Total ..... 2,805,346

MICHIGAN.

AREA, 56,243 SQUARE MILES.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Alcona | 5,691 | Bay | 62,378 | Chippewa | 21,338 | Genesee | 41,804 |
| Alger | 5,868 | Benzie | 9,685 | Clare | 8,360 | Gladwin | 6,564 |
| Allegan | 38,812 | Berrien | 49,165 | Clinton | 25,136 | Gogebic | 16,738 |
| Alpena | 18,254 | Branch | 27,811 | Crawford | 2,943 | Grand Traverse | 20,479 |
| Antrim | 16,568 | Calhoun | 49,315 | Delta | 23,881 | Gratiot | 29,889 |
| Arenac | 9,821 | Cass | 20,876 | Dickinson | 17,890 | Hillsdale | 29,865 |
| Baraga | 4,320 | Charlevoix | 13,956 | Eaton | 31,668 | Houghton | 66,063 |
| Barry | 22,514 | Cheboygan | 15,516 | Emmet | 15,931 | Huron | 34,162 |


Increase of Population during the last 100 years on the present territory of European countries and the United States of America
Population in Millions.
Population in 1900
" " 1850
" " 1800
Austria
Hungary
Belgium
Bavaria
Roumania
Portugal
Holland
Sweden
Saxony
Switzerland
Greece
Servia
Denmark
Norway
European Russia 1900: 112,430,000
United States 1900: 76,303,000
Spain 1900: 18,100,000
Italy 1900: 32,450,000
Prussia 1900: 34,475,000
France 1900: 38,960,000
Increase 3,700,000=10.5%
The population of Ireland has decreased since 1845 from 8,300,000 to 4,450,000
Great-Britain and Ireland 1900: 41,484,000
Austria-Hungary (without Bosnia) 1900: 45,400,000
Germany 1900: 56,370,000
Increase from 1850 to 1900: 53,111,000 =229%
Increase from 1800 to 1850: 17,384,000 =337%
Increase from 1850 to 1900: 50,230,000 =81%
Increase from 1800 to 1850: 23,416,000 =60%
In year 1800: 35,800,000 Pop.
INCREASE IN POPULATION.

MICHIGAN—*Continued.*

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Ingham | 39,818 | Lenawee | 48,406 | Montcalm | 32,754 | Roscommon | 1,787 |
| Ionia | 34,329 | Livingston | 19,664 | Montmorency | 3,234 | Saginaw | 81,222 |
| Iosco | 10,246 | Luce | 2,983 | Muskegon | 37,036 | St. Clair | 55,228 |
| Iron | 8,990 | Mackinac | 7,703 | Newaygo | 17,673 | St. Joseph | 23,889 |
| Isabella | 22,784 | Macomb | 33,244 | Oakland | 44,792 | Sanilac | 35,055 |
| Jackson | 48,222 | Manistee | 27,856 | Oceana | 16,644 | Schoolcraft | 7,889 |
| Kalamazoo | 44,310 | Marquette | 41,239 | Ogemaw | 7,765 | Shiawassee | 33,866 |
| Kalkaska | 7,133 | Mason | 18,885 | Ontonagon | 6,197 | Tuscola | 35,890 |
| Kent | 129,714 | Mecosta | 20,693 | Osceola | 17,859 | Van Buren | 33,274 |
| Keweenaw | 3,217 | Menominee | 27,046 | Oscoda | 1,468 | Washtenaw | 47,731 |
| Lake | 4,957 | Midland | 14,439 | Otsego | 6,175 | Wayne | 348,793 |
| Lapeer | 27,641 | Missaukee | 9,308 | Ottawa | 39,667 | Wexford | 16,845 |
| Leelanau | 10,556 | Monroe | 32,754 | Presque Isle | 8,821 | | |

Total ..... 2,420,982

MINNESOTA.

AREA, 95,274 SQUARE MILES.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Aitkin | 6,743 | Freeborn | 21,838 | Morrison | 22,891 | Sibley | 16,862 |
| Anoka | 11,313 | Goodhue | 31,137 | Mower | 22,335 | Stearns | 44,464 |
| Becker | 14,375 | Grant | 8,935 | Murray | 11,911 | Steele | 16,524 |
| Beltrami | 11,030 | Hennepin | 228,340 | Nicollet | 14,774 | Stevens | 8,721 |
| Benton | 9,912 | Houston | 15,400 | Nobles | 14,932 | Swift | 13,503 |
| Bigstone | 8,731 | Hubbard | 6,578 | Norman | 15,045 | Todd | 22,214 |
| Blue Earth | 32,263 | Isanti | 11,675 | Olmsted | 23,119 | Traverse | 7,573 |
| Brown | 19,787 | Itasca | 4,573 | Ottertail | 45,375 | Wabasha | 18,924 |
| Carlton | 10,017 | Jackson | 14,793 | Pine | 11,546 | Wadena | 7,921 |
| Carver | 17,544 | Kanabec | 4,614 | Pipestone | 9,264 | Waseca | 14,760 |
| Cass | 7,777 | Kandiyohi | 18,416 | Polk | 35,429 | Washington | 27,808 |
| Chippewa | 12,499 | Kittson | 7,889 | Pope | 12,577 | Watonwan | 11,496 |
| Chisago | 13,248 | Lac qui Parle | 14,289 | Ramsey | 170,554 | Wilkin | 8,080 |
| Clay | 17,942 | Lake | 4,654 | Red Lake | 12,195 | Winona | 35,686 |
| Cook | 810 | Lesueur | 20,234 | Redwood | 17,261 | Wright | 29,157 |
| Cottonwood | 12,069 | Lincoln | 8,966 | Renville | 23,693 | White Earth Indian Reservation | 3,486 |
| Crow Wing | 14,250 | Lyon | 14,591 | Rice | 26,080 | | |
| Dakota | 21,733 | McLeod | 19,595 | Rock | 9,668 | | |
| Dodge | 13,340 | Marshall | 15,698 | Roseau | 6,994 | Yellow Medicine | 14,602 |
| Douglas | 17,964 | Martin | 16,936 | St. Louis | 82,932 | | |
| Faribault | 22,055 | Meeker | 17,753 | Scott | 15,147 | | |
| Fillmore | 28,238 | Millelacs | 8,066 | Sherburne | 7,281 | | |

Total ..... 1,751,394

MISSISSIPPI.

AREA, 47,156 SQUARE MILES.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Adams | 30,111 | Grenada | 14,112 | Lowndes | 29,095 | Sharkey | 12,178 |
| Alcorn | 14,987 | Hancock | 11,886 | Madison | 32,493 | Simpson | 12,800 |
| Amite | 20,708 | Harrison | 21,002 | Marion | 13,501 | Smith | 13,055 |
| Attala | 26,248 | Hinds | 52,577 | Marshall | 27,674 | Sunflower | 16,084 |
| Benton | 10,510 | Holmes | 36,828 | Monroe | 31,216 | Tallahatchie | 19,600 |
| Bolivar | 35,427 | Issaquena | 10,400 | Montgomery | 16,536 | Tate | 20,618 |
| Calhoun | 16,512 | Itawamba | 13,544 | Neshoba | 12,726 | Tippah | 12,983 |
| Carroll | 22,116 | Jackson | 16,513 | Newton | 19,708 | Tishomingo | 10,124 |
| Chickasaw | 19,892 | Jasper | 15,394 | Noxubee | 30,846 | Tunica | 16,479 |
| Choctaw | 13,036 | Jefferson | 21,292 | Oktibbeha | 20,183 | Union | 16,522 |
| Claiborne | 20,787 | Jones | 17,846 | Panola | 29,027 | Warren | 40,912 |
| Clarke | 17,741 | Kemper | 20,492 | Pearl River | 6,697 | Washington | 49,216 |
| Clay | 19,563 | Lafayette | 22,110 | Perry | 14,682 | Wayne | 12,539 |
| Coahoma | 26,293 | Lauderdale | 38,150 | Pike | 27,545 | Webster | 13,619 |
| Copiah | 34,395 | Lawrence | 15,103 | Pantotoc | 18,274 | Wilkinson | 21,453 |
| Covington | 13,076 | Leake | 17,360 | Prentiss | 15,788 | Winston | 14,124 |
| De Soto | 24,751 | Lee | 21,956 | Quitman | 5,435 | Yalobusha | 19,742 |
| Franklin | 13,678 | Leflore | 23,834 | Rankin | 20,955 | Yazoo | 43,948 |
| Greene | 6,795 | Lincoln | 21,552 | Scott | 14,316 | | |

Total ..... 1,551,270

## MISSOURI.

AREA, 67,380 SQUARE MILES.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Adair | 21,728 | Dallas | 13,903 | Livingston | 22,302 | Randolph | 24,442 |
| Andrew | 17,332 | Daviess | 21,325 | McDonald | 13,574 | Ray | 24,805 |
| Atchison | 16,501 | Dekalb | 14,418 | Macon | 33,018 | Reynolds | 8,161 |
| Audrain | 21,160 | Dent | 12,986 | Madison | 9,975 | Ripley | 13,186 |
| Barry | 25,532 | Douglas | 16,802 | Maries | 9,616 | St. Charles | 24,474 |
| Barton | 18,253 | Dunklin | 21,706 | Marion | 26,331 | St. Clair | 17,907 |
| Bates | 30,141 | Franklin | 30,581 | Mercer | 14,706 | Ste. Genevieve | 10,359 |
| Benton | 16,556 | Gasconade | 12,298 | Miller | 15,187 | St. Francois | 24,051 |
| Bollinger | 14,650 | Gentry | 20,554 | Mississippi | 11,837 | St. Louis | 50,040 |
| Boone | 28,642 | Greene | 52,713 | Moniteau | 15,931 | St. Louis City | 575,238 |
| Buchanan | 121,838 | Grundy | 17,832 | Monroe | 19,716 | Saline | 33,703 |
| Butler | 16,769 | Harrison | 24,398 | Montgomery | 16,571 | Schuyler | 10,840 |
| Caldwell | 16,656 | Henry | 28,054 | Morgan | 12,175 | Scotland | 13,232 |
| Callaway | 25,984 | Hickory | 9,985 | New Madrid | 11,280 | Scott | 13,092 |
| Camden | 13,113 | Holt | 17,083 | Newton | 27,001 | Shannon | 11,247 |
| Cape Girardeau | 24,315 | Howard | 18,337 | Nodaway | 32,938 | Shelby | 16,167 |
| Carroll | 26,455 | Howell | 21,834 | Oregon | 13,906 | Stoddard | 24,669 |
| Carter | 6,706 | Iron | 8,716 | Osage | 14,096 | Stone | 9,892 |
| Cass | 23,636 | Jackson | 195,193 | Ozark | 12,145 | Sullivan | 20,282 |
| Cedar | 16,923 | Jasper | 84,018 | Pemiscot | 12,115 | Taney | 10,127 |
| Chariton | 26,826 | Jefferson | 25,712 | Perry | 15,134 | Texas | 22,192 |
| Christian | 16,939 | Johnson | 27,843 | Pettis | 32,438 | Vernon | 31,619 |
| Clark | 15,383 | Knox | 13,479 | Phelps | 14,194 | Warren | 9,919 |
| Clay | 18,903 | Laclede | 16,523 | Pike | 25,744 | Washington | 14,263 |
| Clinton | 17,363 | Lafayette | 31,679 | Platte | 16,193 | Wayne | 15,309 |
| Cole | 20,578 | Lawrence | 31,662 | Polk | 23,255 | Webster | 16,640 |
| Cooper | 22,532 | Lewis | 16,724 | Pulaski | 10,394 | Worth | 9,832 |
| Crawford | 12,959 | Lincoln | 18,352 | Putnam | 16,688 | Wright | 17,519 |
| Dade | 18,125 | Linn | 25,503 | Ralls | 12,287 | | |

Total ..... 3,106,665

## MONTANA.

AREA, 143,776 SQUARE MILES.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Beaverhead | 5,615 | Deerlodge | 17,393 | Madison | 7,695 | Teton | 5,080 |
| Broadwater | 2,641 | Fergus | 6,937 | Meagher | 2,526 | Valley | 4,355 |
| Carbon | 7,533 | Flathead | 9,375 | Missoula | 13,964 | Yellowstone | 6,212 |
| Cascade | 25,777 | Gallatin | 9,553 | Park | 7,341 | Crow Indian Reservation | 2,660 |
| Choteau | 10,966 | Granite | 4,328 | Ravalli | 7,822 | | |
| Custer | 7,891 | Jefferson | 5,330 | Silverbow | 47,635 | | |
| Dawson | 2,443 | Lewis and Clarke | 19,171 | Sweet Grass | 3,086 | | |

Total ..... 243,339

## NEBRASKA.

AREA, 75,995 SQUARE MILES.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Adams | 18,840 | Deuel | 2,630 | Johnson | 11,197 | Redwillow | 9,604 |
| Antelope | 11,344 | Dixon | 10,535 | Kearney | 9,866 | Richardson | 19,614 |
| Banner | 1,114 | Dodge | 22,298 | Keith | 1,951 | Rock | 2,809 |
| Blaine | 603 | Douglas | 140,590 | Keyapaha | 3,076 | Saline | 18,252 |
| Boone | 11,689 | Dundy | 2,434 | Kimball | 758 | Sarpy | 9,080 |
| Boxbutte | 5,572 | Fillmore | 15,087 | Knox | 14,343 | Saunders | 22,085 |
| Boyd | 7,332 | Franklin | 9,455 | Lancaster | 64,835 | Scotts Bluff | 2,552 |
| Brown | 3,470 | Frontier | 8,781 | Lincoln | 11,416 | Seward | 15,690 |
| Buffalo | 20,254 | Furnas | 12,373 | Logan | 960 | Sheridan | 6,033 |
| Burt | 13,040 | Gage | 30,051 | Loup | 1,305 | Sherman | 6,550 |
| Butler | 15,703 | Garfield | 2,127 | McPherson | 517 | Sioux | 2,055 |
| Cass | 21,330 | Gosper | 5,301 | Madison | 16,976 | Stanton | 6,959 |
| Cedar | 12,467 | Grant | 763 | Merrick | 9,255 | Thayer | 14,325 |
| Chase | 2,559 | Greeley | 5,691 | Nance | 8,222 | Thomas | 628 |
| Cherry | 6,541 | Hall | 17,206 | Nemaha | 14,952 | Thurston | 8,756 |
| Cheyenne | 5,570 | Hamilton | 13,330 | Nuckolls | 12,414 | Valley | 7,339 |
| Clay | 15,735 | Harlan | 9,370 | Otoe | 22,288 | Washington | 13,086 |
| Colfax | 11,211 | Hayes | 2,708 | Pawnee | 11,770 | Wayne | 9,862 |
| Cuming | 14,584 | Hitchcock | 4,409 | Perkins | 1,702 | Webster | 11,619 |
| Custer | 19,758 | Holt | 12,224 | Phelps | 10,772 | Wheeler | 1,362 |
| Dakota | 6,286 | Hooker | 432 | Pierce | 8,445 | York | 18,205 |
| Dawes | 6,215 | Howard | 10,343 | Platte | 17,747 | | |
| Dawson | 12,214 | Jefferson | 15,196 | Polk | 10,542 | | |

Total ..... 1,068,539

## NEVADA.

AREA, 122,090 SQUARE MILES.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Churchill | 830 | Eureka | 1,954 | Lyon | 2,268 | Washoe | 9,141 |
| Douglas | 1,534 | Humboldt | 4,463 | Nye | 1,140 | White Pine | 1,961 |
| Elko | 5,688 | Lander | 1,534 | Ormsby | 2,893 | | |
| Esmeralda | 1,972 | Lincoln | 3,284 | Storey | 3,673 | | |

Total ..... 42,335

## NEW HAMPSHIRE.

AREA, 9,280 SQUARE MILES.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Belknap | 19,526 | Coos | 29,468 | Merrimack | 52,430 | Sullivan | 18 009 |
| Carroll | 16,895 | Grafton | 40,844 | Rockingham | 51,118 | | |
| Cheshire | 31,321 | Hillsboro | 112,640 | Strafford | 39,337 | | |

Total ..... 411,588

## NEW JERSEY.

AREA, 3,320 SQUARE MILES.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Atlantic | 46,402 | Essex | 359,053 | Monmouth | 82,057 | Sussex | 24,134 |
| Bergen | 78,441 | Gloucester | 31,905 | Morris | 65,156 | Union | 99,353 |
| Burlington | 58,241 | Hudson | 386,048 | Ocean | 19,747 | Warren | 37,781 |
| Camden | 107,643 | Hunterdon | 34,507 | Passaic | 155,202 | | |
| Cape May | 13,201 | Mercer | 95,365 | Salem | 25,530 | | |
| Cumberland | 51,193 | Middlesex | 79,762 | Somerset | 32,948 | | |

Total ..... 1,883,669

## NEW MEXICO.

AREA, 121,201 SQUARE MILES.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Bernalillo | 28,630 | Grant | 12,883 | Rio Arriba | 13,777 | Socorro | 12,195 |
| Chaves | 4,773 | Guadalupe | 5,429 | San Juan | 4,828 | Taos | 10,889 |
| Colfax | 10,150 | Lincoln | 4,953 | San Miguel | 22,053 | Union | 4,528 |
| Donna Ana | 10,187 | Mora | 10,304 | Santa Fe | 14,658 | Valencia | 13,895 |
| Eddy | 3,229 | Otero | 4,791 | Sierra | 3,158 | | |

Total ..... 195,310

## NEW YORK.

AREA, 47,800 SQUARE MILES.

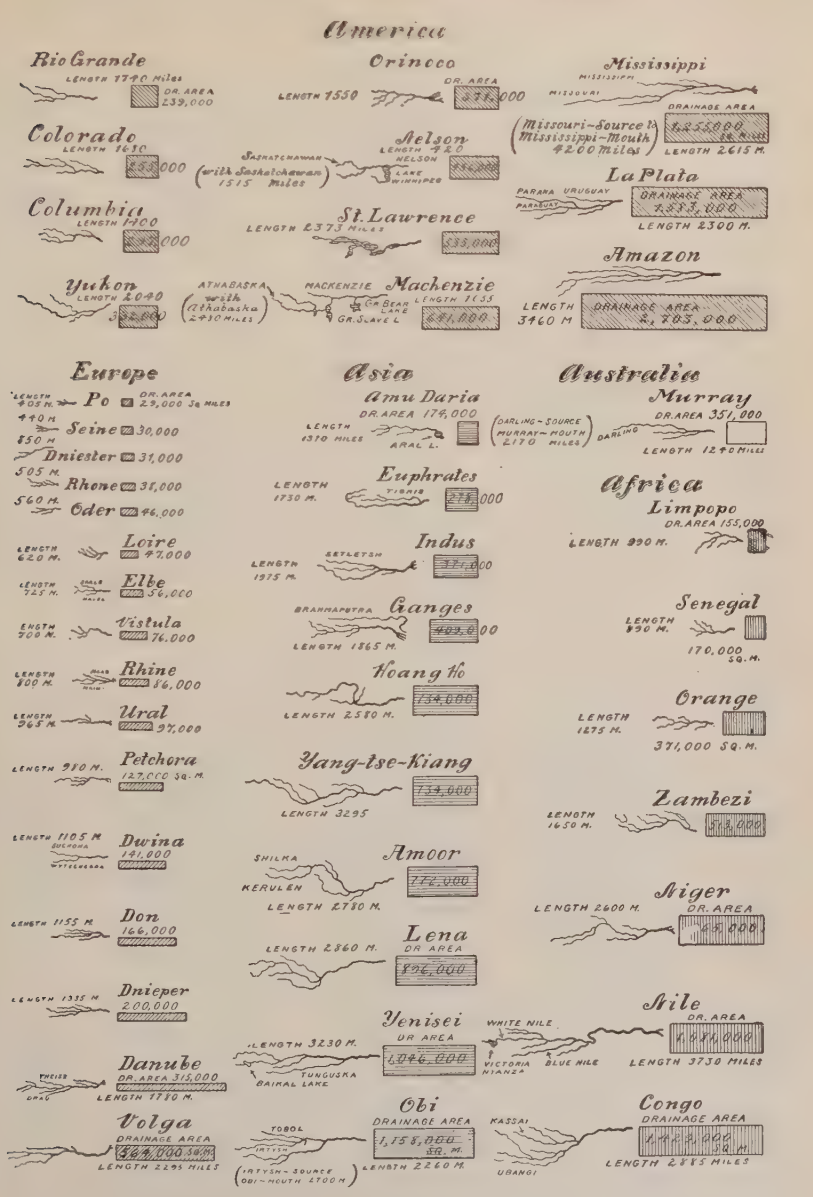
| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Albany | 165,571 | Fulton | 42,842 | Onondaga | 168,735 | Seneca | 28,114 |
| Allegany | 41,501 | Genesee | 34,561 | Ontario | 49,605 | Steuben | 82,822 |
| Broome | 69,149 | Greene | 31,478 | Orange | 103,859 | Suffolk | 77,582 |
| Cattaraugus | 65,643 | Hamilton | 4,947 | Orleans | 30,164 | Sullivan | 32,306 |
| Cayuga | 66,234 | Herkimer | 51,049 | Oswego | 70,881 | Tioga | 27,951 |
| Chautauqua | 88,314 | Jefferson | 76,748 | Otsego | 48,939 | Tompkins | 33,830 |
| Chemung | 54,063 | Kings | 1,166,582 | Putnam | 13,787 | Ulster | 88,422 |
| Chenango | 36,568 | Lewis | 27,427 | Queens | 152,999 | Warren | 29,943 |
| Clinton | 47,430 | Livingston | 37,059 | Rensselaer | 121,697 | Washington | 45,624 |
| Columbia | 43,211 | Madison | 40,545 | Richmond | 67,021 | Wayne | 48,660 |
| Cortland | 27,576 | Monroe | 217,854 | Rockland | 38,298 | Westchester | 183,375 |
| Delaware | 46,413 | Montgomery | 47,488 | St. Lawrence | 89,083 | Wyoming | 30,413 |
| Dutchess | 81,670 | Nassau | 55,448 | Saratoga | 61,089 | Yates | 20,318 |
| Erie | 433,686 | New York | 2,050,600 | Schenectady | 46,852 | | |
| Essex | 30,707 | Niagara | 74,961 | Schoharie | 26,854 | | |
| Franklin | 42,853 | Oneida | 132,800 | Schuyler | 15,811 | | |

Total ..... 7,268,012

## NORTH CAROLINA.

AREA, 50,704 SQUARE MILES.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Alamance | 25,665 | Burke | 17,699 | Clay | 4,532 | Durham | 26,233 |
| Alexander | 10,960 | Cabarrus | 22,456 | Cleveland | 25,078 | Edgecombe | 26,591 |
| Alleghany | 7,759 | Caldwell | 15,694 | Columbus | 21,274 | Forsyth | 35,261 |
| Anson | 21,870 | Camden | 5,474 | Craven | 24,160 | Franklin | 25,116 |
| Ashe | 19,581 | Carteret | 11,811 | Cumberland | 29,249 | Gaston | 27,903 |
| Beaufort | 26,404 | Caswell | 15,028 | Currituck | 6,529 | Gates | 10,413 |
| Bertie | 20,538 | Catawba | 22,133 | Dare | 4,757 | Graham | 4,343 |
| Bladen | 17,677 | Chatham | 23,912 | Davidson | 23,403 | Granville | 23,263 |
| Brunswick | 12,657 | Cherokee | 11,860 | Davie | 12,115 | Greene | 12,038 |
| Buncombe | 44,288 | Chowan | 10,258 | Duplin | 22,405 | Guilford | 39,074 |




RIVERS OF THE WORLD.

NORTH CAROLINA—*Continued.*

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Halifax | 30,793 | Madison | 20,644 | Perquimans | 10,091 | Swain | 8,401 |
| Harnett | 15,988 | Martin | 15,383 | Person | 16,685 | Transylvania | 6,620 |
| Haywood | 16,222 | Mecklenburg | 55,268 | Pitt | 30,889 | Tyrrell | 4,980 |
| Henderson | 14,104 | Mitchell | 15,221 | Polk | 7,004 | Union | 27,156 |
| Hertford | 14,294 | Montgomery | 14,197 | Randolph | 28,232 | Vance | 16,684 |
| Hyde | 9,278 | Moore | 23,622 | Richmond | 15,855 | Wake | 54,626 |
| Iredell | 29,064 | Nash | 25,478 | Robeson | 40,371 | Warren | 19,151 |
| Jackson | 11,853 | New Hanover | 25,785 | Rockingham | 33,163 | Washington | 10,608 |
| Johnston | 32,250 | Northampton | 21,150 | Rowan | 31,066 | Watauga | 13,417 |
| Jones | 8,226 | Onslow | 11,940 | Rutherford | 25,101 | Wayne | 31,356 |
| Lenoir | 18,639 | Orange | 14,690 | Sampson | 26,380 | Wilkes | 26,872 |
| Lincoln | 15,498 | Pamlico | 8,045 | Stanly | 15,220 | Wilson | 23,596 |
| McDowell | 12,567 | Pasquotank | 13,660 | Stokes | 19,866 | Yadkin | 14,083 |
| Macon | 12,104 | Pender | 13,381 | Surry | 25,515 | Yancey | 11,464 |
| Total | | | | | | | 1,893,810 |

NORTH DAKOTA.

AREA, 72,000 SQUARE MILES.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Barnes | 13,159 | Grand Forks | 24,459 | Oliver | 990 | Towner | 6,491 |
| Benson | 8,320 | Griggs | 4,744 | Pembina | 17,869 | Traill | 13,107 |
| Billings | 975 | Kidder | 1,754 | Pierce | 4,765 | Walsh | 20,288 |
| Bottineau | 7,532 | Lamoure | 6,048 | Ramsey | 9,198 | Ward | 7,961 |
| Burleigh | 6,081 | Logan | 1,625 | Ransom | 6,919 | Wells | 8,310 |
| Cass | 28,625 | McHenry | 5,253 | Richland | 17,387 | Williams | 1,530 |
| Cavalier | 12,580 | McIntosh | 4,818 | Rolette | 7,995 | Standing Rock Indian Reservation | 2,208 |
| Dickey | 6,061 | McLean | 4,791 | Sargent | 6,039 | | |
| Eddy | 3,330 | Mercer | 1,778 | Stark | 7,621 | | |
| Emmons | 4,349 | Morton | 8,069 | Steele | 5,888 | | |
| Foster | 3,770 | Nelson | 7,316 | Stutsman | 9,143 | | |
| Total | | | | | | | 319,146 |

OHIO.

AREA, 39,964 SQUARE MILES.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Adams | 26,328 | Fairfield | 34,259 | Licking | 47,070 | Portage | 29,246 |
| Allen | 47,976 | Fayette | 21,725 | Logan | 30,420 | Preble | 23,713 |
| Ashland | 21,184 | Franklin | 164,460 | Lorain | 54,857 | Putnam | 32,525 |
| Ashtabula | 51,448 | Fulton | 22,801 | Lucas | 153,559 | Richland | 44,289 |
| Athens | 38,730 | Gallia | 27,918 | Madison | 20,590 | Ross | 40,940 |
| Auglaize | 31,192 | Geauga | 14,744 | Mahoning | 70,134 | Sandusky | 34,311 |
| Belmont | 60,875 | Greene | 31,613 | Marion | 28,678 | Scioto | 40,981 |
| Brown | 28,237 | Guernsey | 34,425 | Medina | 21,958 | Seneca | 41,163 |
| Butler | 56,870 | Hamilton | 409,479 | Meigs | 28,620 | Shelby | 24,625 |
| Carroll | 16,811 | Hancock | 41,993 | Mercer | 28,021 | Stark | 94,747 |
| Champaign | 26,642 | Hardin | 31,187 | Miami | 43,105 | Summit | 71,715 |
| Clark | 58,939 | Harrison | 20,486 | Monroe | 27,031 | Trumbull | 46,591 |
| Clermont | 31,610 | Henry | 27,282 | Montgomery | 130,146 | Tuscarawas | 53,751 |
| Clinton | 24,202 | Highland | 30,982 | Morgan | 17,905 | Union | 22,342 |
| Columbiana | 68,590 | Hocking | 24,398 | Morrow | 17,879 | Van Wert | 30,394 |
| Coshocton | 29,337 | Holmes | 19,511 | Muskingum | 53,185 | Vinton | 15,330 |
| Crawford | 33,915 | Huron | 32,330 | Noble | 19,466 | Warren | 25,584 |
| Cuyahoga | 439,120 | Jackson | 34,248 | Ottawa | 22,213 | Washington | 48,245 |
| Darke | 42,532 | Jefferson | 44,357 | Paulding | 27,528 | Wayne | 87,870 |
| Defiance | 26,387 | Knox | 27,768 | Perry | 31,841 | Williams | 24,953 |
| Delaware | 26,401 | Lake | 21,680 | Pickaway | 27,016 | Wood | 51,555 |
| Erie | 37,650 | Lawrence | 39,534 | Pike | 18,172 | Wyandot | 21,125 |
| Total | | | | | | | 4,157,545 |

OKLAHOMA.

AREA, 2,950 SQUARE MILES.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Beaver | 3,051 | Garfield | 22,076 | Noble | 14,015 | Woods | 34,975 |
| Blaine | 10,658 | Grant | 17,273 | Oklahoma | 25,854 | Woodward | 7,469 |
| Canadian | 15,981 | Greer | 17,922 | Pawnee | 12,366 | Indian Reservations | 12,873 |
| Cleveland | 16,388 | Kay | 22,530 | Payne | 20,909 | | |
| Custer | 12,264 | Kingfisher | 18,501 | Pottawatomie | 26,412 | | |
| Day | 2,173 | Lincoln | 27,007 | Roger Mills | 6,190 | | |
| Dewey | 8,819 | Logan | 26,538 | Washita | 15,001 | | |
| Total | | | | | | | 398,331 |

## OREGON.

AREA, 102,606 SQUARE MILES.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Baker | 15,597 | Gilliam | 3,201 | Linn | 18,603 | Union | 16,070 |
| Benton | 6,706 | Grant | 5,948 | Malheur | 4,203 | Wallowa | 5,538 |
| Clackamas | 19,658 | Harney | 2,598 | Marion | 27,713 | Wasco | 13,199 |
| Clatsop | 12,765 | Jackson | 13,698 | Morrow | 4,151 | Washington | 14,467 |
| Columbia | 6,237 | Josephine | 7,517 | Multnomah | 103,167 | Wheeler | 2,443 |
| Coos | 10,324 | Klamath | 3,970 | Polk | 9,923 | Yamhill | 13,420 |
| Crook | 3,964 | Lake | 2,847 | Sherman | 3,477 | | |
| Curry | 1,868 | Lane | 19,604 | Tillamook | 4,471 | | |
| Douglas | 14,565 | Lincoln | 3,575 | Umatilla | 18,049 | | |
| Total | | | | | | | 413,536 |

## PENNSYLVANIA.

AREA, 46,000 SQUARE MILES.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Adams | 34,496 | Clinton | 29,197 | Lackawanna | 193,831 | Philadelphia | 1,293,697 |
| Allegheny | 775,058 | Columbia | 39,896 | Lancaster | 159 241 | Pike | 8,766 |
| Armstrong | 52,551 | Crawford | 63,343 | Lawrence | 57,042 | Potter | 30,621 |
| Beaver | 56,432 | Cumberland | 50,344 | Lebanon | 53,827 | Schuylkill | 172,927 |
| Bedford | 39,468 | Dauphin | 114,443 | Lehigh | 93,893 | Snyder | 17,304 |
| Berks | 159,615 | Delaware | 94,762 | Luzerne | 257,121 | Somerset | 49,461 |
| Blair | 85,099 | Elk | 32,903 | Lycoming | 75,663 | Sullivan | 12,134 |
| Bradford | 59,403 | Erie | 98,473 | McKean | 51,343 | Susquehanna | 40,043 |
| Bucks | 71,190 | Fayette | 110,412 | Mercer | 57,387 | Tioga | 49,086 |
| Butler | 56,962 | Forest | 11,039 | Mifflin | 23,160 | Union | 17,592 |
| Cambria | 104,837 | Franklin | 54,902 | Monroe | 21,161 | Venango | 49,648 |
| Cameron | 7,048 | Fulton | 9,924 | Montgomery | 138,995 | Warren | 38,946 |
| Carbon | 44,510 | Greene | 28,281 | Montour | 15,526 | Washington | 92,181 |
| Center | 42,894 | Huntingdon | 34,650 | Northampton | 99,687 | Wayne | 30,171 |
| Chester | 95,695 | Indiana | 42,556 | Northumberland | 90,911 | Westmoreland | 160,175 |
| Clarion | 34,283 | Jefferson | 59,113 | | | Wyoming | 17,152 |
| Clearfield | 80,614 | Juniata | 16,054 | Perry | 26,263 | York | 116,413 |
| Total | | | | | | | 6,302,115 |

## RHODE ISLAND.

AREA, 1,306 SQUARE MILES.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Bristol | 13,144 | Newport | 32,599 | Providence | 328,683 | Washington | 24,154 |
| Kent | 29,976 | | | | | | |
| Total | | | | | | | 428,556 |

## SOUTH CAROLINA.

AREA, 29,385 SQUARE MILES.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Abbeville | 33,400 | Chesterfield | 20,401 | Greenwood | 28,343 | Oconee | 23,634 |
| Aiken | 39,032 | Clarendon | 28,184 | Hampton | 23,738 | Orangeburg | 59,663 |
| Anderson | 55,728 | Colleton | 33,452 | Horry | 23,364 | Pickens | 19,375 |
| Bamberg | 17,296 | Darlington | 32,388 | Kershaw | 24,696 | Richland | 45,589 |
| Barnwell | 35,504 | Dorchester | 16,294 | Lancaster | 24,311 | Saluda | 18,966 |
| Beaufort | 35,495 | Edgefield | 25,478 | Laurens | 37,382 | Spartanburg | 65,560 |
| Berkeley | 30,454 | Fairfield | 29,425 | Lexington | 27,264 | Sumter | 51,237 |
| Charleston | 88,006 | Florence | 28,474 | Marion | 35,181 | Union | 25,501 |
| Cherokee | 21,359 | Georgetown | 22,846 | Marlboro | 27,639 | Williamsburg | 31,685 |
| Chester | 28,616 | Greenville | 53,490 | Newberry | 30,182 | York | 41,684 |
| Total | | | | | | | 1,340,316 |

## SOUTH DAKOTA.

AREA, 78,932 SQUARE MILES.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Aurora | 4,011 | Davison | 7,483 | Hyde | 1,492 | Pennington | 5,610 |
| Beadle | 8,081 | Day | 12,254 | Jerauld | 2,798 | Potter | 2,988 |
| Bonhomme | 10,379 | Deuel | 6,656 | Kingsbury | 9,866 | Roberts | 12,216 |
| Brookings | 12,561 | Douglas | 5,012 | Lake | 9,137 | Sanborn | 4,644 |
| Brown | 15,286 | Edmunds | 4,916 | Lawrence | 17,897 | Spink | 9,487 |
| Brule | 5,401 | Fall River | 3,541 | Lincoln | 12,161 | Stanley | 1,349 |
| Buffalo | 1,790 | Faulk | 3,547 | Lyman | 2,632 | Sully | 1,715 |
| Butte | 2,907 | Grant | 9,103 | McCook | 8,689 | Turner | 13,175 |
| Campbell | 4,527 | Gregory | 2,211 | McPherson | 6,327 | Union | 11,153 |
| Charles Mix | 8,498 | Hamlin | 5,945 | Marshall | 5,942 | Walworth | 3,839 |
| Clark | 6,942 | Hand | 4,525 | Meade | 4,907 | Yankton | 12,649 |
| Clay | 9,316 | Hanson | 4,947 | Miner | 5,864 | Indian Reservation | 16,043 |
| Coddington | 8,770 | Hughes | 3,684 | Minnehaha | 23,926 | | |
| Custer | 2,728 | Hutchinson | 11,897 | Moody | 8,326 | | |
| Total | | | | | | | 401,570 |

## TENNESSEE.

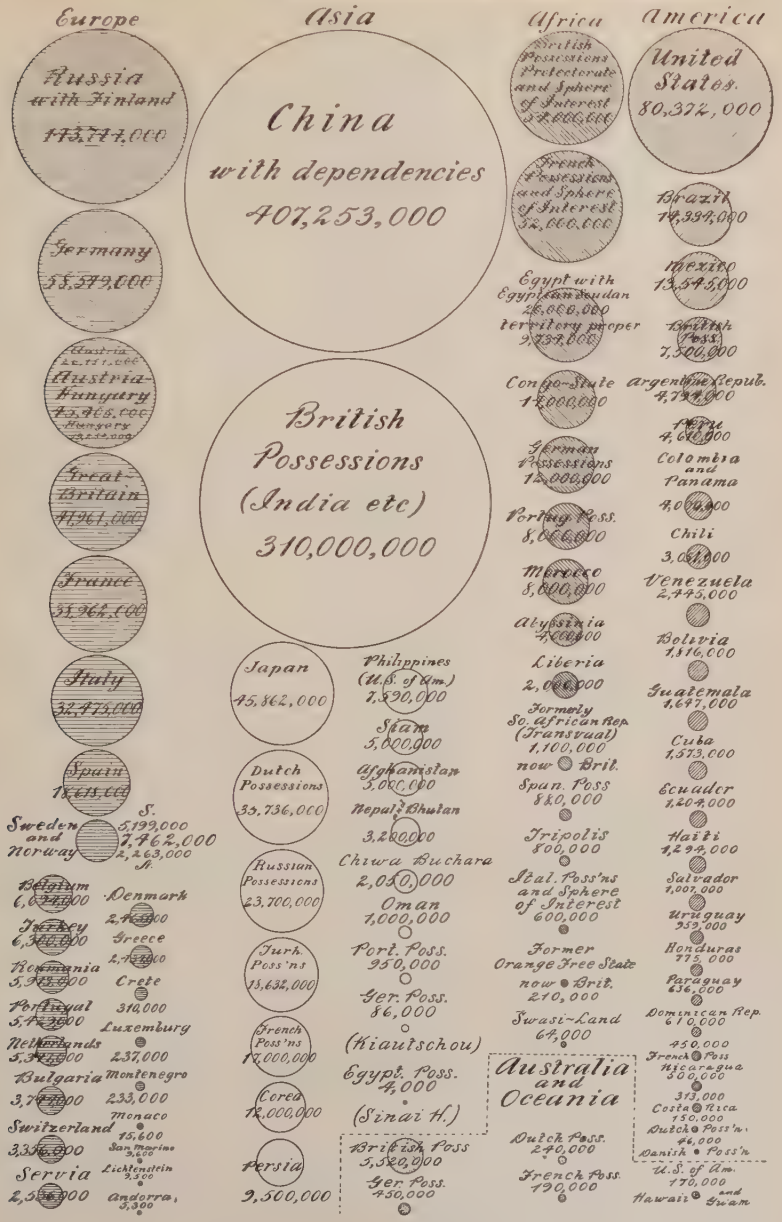
AREA, 45,500 SQUARE MILES.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Anderson | 17,634 | Fentress | 6,106 | Lake | 7,368 | Rhea | 14,318 |
| Bedford | 23,845 | Franklin | 20,392 | Lauderdale | 21,971 | Roane | 22,738 |
| Benton | 11,888 | Gibson | 39,408 | Lawrence | 15,402 | Robertson | 25,029 |
| Bledsoe | 6,626 | Giles | 33,035 | Lewis | 4,455 | Rutherford | 33,543 |
| Blount | 19,206 | Grainger | 15,512 | Lincoln | 26,304 | Scott | 11,077 |
| Bradley | 15,759 | Greene | 30,596 | Loudon | 10,838 | Sequatchie | 3,326 |
| Campbell | 17,317 | Grundy | 7,802 | McMinn | 19,163 | Sevier | 22,021 |
| Cannon | 12,121 | Hamblen | 12,728 | McNairy | 17,760 | Shelby | 153,557 |
| Carroll | 24,250 | Hamilton | 61,695 | Macon | 12,881 | Smith | 19,026 |
| Carter | 16,688 | Hancock | 11,147 | Madison | 36,333 | Stewart | 15,224 |
| Cheatham | 10,112 | Hardeman | 22,976 | Marion | 17,281 | Sullivan | 24,935 |
| Chester | 9,896 | Hardin | 19,246 | Marshall | 18,763 | Sumner | 26,072 |
| Claiborne | 20,696 | Hawkins | 24,267 | Maury | 42,703 | Tipton | 29,273 |
| Clay | 8,421 | Haywood | 25,189 | Meigs | 7,491 | Trousdale | 6,004 |
| Cocke | 19,153 | Henderson | 18,117 | Monroe | 18,585 | Unicoi | 5,851 |
| Coffee | 15,574 | Henry | 24,208 | Montgomery | 36,017 | Union | 12,894 |
| Crockett | 15,867 | Hickman | 16,367 | Moore | 5,706 | Van Buren | 3,126 |
| Cumberland | 8,311 | Houston | 6,476 | Morgan | 9,587 | Warren | 16,410 |
| Davidson | 122,815 | Humphreys | 13,398 | Obion | 28,286 | Washington | 22,604 |
| Decatur | 10,439 | Jackson | 15,039 | Overton | 13,353 | Wayne | 12,936 |
| Dekalb | 16,460 | James | 5,407 | Perry | 8,800 | Weakley | 32,546 |
| Dickson | 18,635 | Jefferson | 18,590 | Pickett | 5,366 | White | 14,157 |
| Dyer | 23,776 | Johnson | 10,589 | Polk | 11,357 | Williamson | 26,429 |
| Fayette | 29,701 | Knox | 74,302 | Putnam | 16,890 | Wilson | 27,078 |
| Total | | | | | | | 2,020,616 |

## TEXAS.

AREA, 237,504 SQUARE MILES.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Anderson | 28,015 | Collingsworth | 1,233 | Glasscock | 286 | Kerr | 4,980 |
| Andrews | 87 | Colorado | 22,203 | Goliad | 8,310 | Kimble | 2,503 |
| Angelina | 13,481 | Comal | 7,008 | Gonzales | 28,882 | King | 490 |
| Aransas | 1,716 | Comanche | 23,009 | Gray | 480 | Kinney | 2,447 |
| Archer | 2,508 | Concho | 1,427 | Grayson | 63,661 | Knox | 2,322 |
| Armstrong | 1,205 | Cooke | 27,494 | Gregg | 12,343 | Lamar | 48,627 |
| Atascosa | 7,143 | Coryell | 21,308 | Grimes | 26,106 | Lamb | 31 |
| Austin | 20,676 | Cottle | 1,002 | Guadalupe | 21,385 | Lampasas | 8,625 |
| Bailey | 4 | Crane | 51 | Hale | 1,680 | Lasalle | 2,303 |
| Bandera | 5,332 | Crockett | 1,591 | Hall | 1,670 | Lavaca | 28,121 |
| Bastrop | 26,845 | Crosby | 788 | Hamilton | 13,520 | Lee | 14,595 |
| Baylor | 3,052 | Dallam | 146 | Hansford | 167 | Leon | 18,072 |
| Bee | 7,720 | Dallas | 82,726 | Hardeman | 3,634 | Liberty | 8,102 |
| Bell | 45,535 | Dawson | 37 | Hardin | 5,049 | Limestone | 32,573 |
| Bexar | 69,422 | Deaf Smith | 843 | Harris | 63,786 | Lipscomb | 790 |
| Blanco | 4,703 | Delta | 15,249 | Harrison | 31,878 | Live Oak | 2 268 |
| Borden | 776 | Denton | 28,318 | Hartley | 377 | Llano | 7,301 |
| Bosque | 17,390 | Dewitt | 21,311 | Haskell | 2,637 | Loving | 33 |
| Bowie | 26,676 | Dickens | 1,151 | Hays | 14,142 | Lubbock | 293 |
| Brazoria | 14,861 | Dimmit | 1,106 | Hemphill | 815 | Lynn | 17 |
| Brazos | 18,859 | Donley | 2,756 | Henderson | 19,970 | McCulloch | 3,960 |
| Brewster | 2,356 | Duval | 8,483 | Hidalgo | 6,837 | McLennan | 59,772 |
| Briscoe | 1,253 | Eastland | 18,971 | Hill | 41,355 | McMullen | 1,024 |
| Brown | 16,019 | Ector | 381 | Hockley | 44 | Madison | 10,432 |
| Burleson | 18,367 | Edwards | 3,108 | Hood | 9,146 | Marion | 10,754 |
| Burnet | 10,528 | Ellis | 50,059 | Hopkins | 27,950 | Martin | 332 |
| Caldwell | 21,765 | El Paso | 24,886 | Houston | 25,452 | Mason | 5,573 |
| Calhoun | 2,395 | Erath | 29,966 | Howard | 2,528 | Matagorda | 6,097 |
| Callahan | 8,768 | Falls | 33,342 | Hunt | 47,295 | Maverick | 4,066 |
| Cameron | 16,095 | Fannin | 51,793 | Hutchinson | 303 | Medina | 7,783 |
| Camp | 9,146 | Fayette | 36,542 | Irion | 848 | Menard | 2,011 |
| Carson | 469 | Fisher | 3,708 | Jack | 10,224 | Midland | 1,741 |
| Cass | 22,841 | Floyd | 2,020 | Jackson | 6,094 | Milam | 39,666 |
| Castro | 400 | Foard | 1,568 | Jasper | 7,138 | Mills | 7,851 |
| Chambers | 3,046 | Fort Bend | 16,538 | Jeff Davis | 1,150 | Mitchell | 2,855 |
| Cherokee | 25,154 | Franklin | 8,674 | Jefferson | 14,239 | Montague | 24,800 |
| Childress | 2,138 | Freestone | 18,910 | Johnson | 33,819 | Montgomery | 17,067 |
| Clay | 9,231 | Frio | 4,200 | Jones | 7,053 | Moore | 209 |
| Cochran | 25 | Gaines | 55 | Karnes | 8,681 | Morris | 8,220 |
| Coke | 3,430 | Galveston | 44,116 | Kaufman | 33,376 | Motley | 1,257 |
| Coleman | 10,077 | Garza | 185 | Kendall | 4,103 | Nacogdoches | 24.663 |
| Collin | 50,087 | Gillespie | 8,229 | Kent | 899 | Navarro | 43,374 |




POPULATION OF THE WORLD.

TEXAS—*Continued.*

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Newton | 7,282 | Roberts | 620 | Sterling | 1,127 | Walker | 15,813 |
| Nolan | 2,611 | Robertson | 31,480 | Stonewall | 2,183 | Waller | 14,246 |
| Nueces | 10,439 | Rockwall | 8,531 | Sutton | 1,727 | Ward | 1,451 |
| Ochiltree | 267 | Runnels | 5,379 | Swisher | 1,227 | Washington | 32,931 |
| Oldham | 349 | Rusk | 26,099 | Tarrant | 52,376 | Webb | 21,851 |
| Orange | 5,905 | Sabine | 6,394 | Taylor | 10,499 | Wharton | 16,942 |
| Palo Pinto | 12,291 | San Augustine | 8,434 | Terry | 48 | Wheeler | 636 |
| Panola | 21,404 | San Jacinto | 10,277 | Throckmorton | 1,750 | Wichita | 5,806 |
| Parker | 25,823 | San Patricio | 2,372 | Titus | 12,292 | Wilbarger | 5,759 |
| Parmer | 34 | San Saba | 7,569 | Tom Green | 6,804 | Williamson | 38,072 |
| Pecos | 2,360 | Schleicher | 515 | Travis | 47,386 | Wilson | 13,961 |
| Polk | 14,447 | Scurry | 4,151 | Trinity | 10,976 | Winkler | 60 |
| Potter | 1,820 | Shackelford | 2,468 | Tyler | 11,899 | Wise | 27,116 |
| Presidio | 3,673 | Shelby | 20,452 | Upshur | 16,266 | Wood | 21,048 |
| Rains | 6,127 | Sherman | 104 | Upton | 48 | Yoakum | 26 |
| Randall | 963 | Smith | 37,370 | Uvalde | 4,647 | Young | 6,540 |
| Red River | 29,893 | Somervell | 3,498 | Valverde | 5,263 | Zapata | 4,760 |
| Reeves | 1,847 | Starr | 11,469 | Van Zandt | 25,481 | Zavalla | 792 |
| Refugio | 1,641 | Stephens | 6,466 | Victoria | 13,678 | | |

Total ..... 3,048,710

UTAH.

AREA, 84,476 SQUARE MILES.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Beaver | 3,613 | Grand | 1,149 | Rich | 1,946 | Uinta | 6,458 |
| Boxelder | 10,009 | Iron | 3,546 | Salt Lake | 77,725 | Utah | 32,456 |
| Cache | 18,139 | Juab | 10,082 | San Juan | 1,023 | Wasatch | 4,736 |
| Carbon | 5,004 | Kane | 1,811 | Sanpete | 16,313 | Washington | 4,612 |
| Davis | 7,996 | Millard | 5,678 | Sevier | 8,451 | Wayne | 1,907 |
| Emery | 4,657 | Morgan | 2,045 | Summit | 9,439 | Weber | 25,239 |
| Garfield | 3,400 | Piute | 1,954 | Tooele | 7,361 | | |

Total ..... 276,749

VERMONT.

AREA, 10,212 SQUARE MILES.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Addison | 21,912 | Essex | 8,056 | Orange | 19,313 | Windham | 26,660 |
| Bennington | 21,705 | Franklin | 30,198 | Orleans | 22,024 | Windsor | 32,225 |
| Caledonia | 24,381 | Grand Isle | 4,462 | Rutland | 44,209 | | |
| Chittenden | 39,600 | Lamoille | 12,289 | Washington | 36,607 | | |

Total ..... 343,641

VIRGINIA.

AREA, 38,352 SQUARE MILES.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Accomac | 32,570 | Dickenson | 7,747 | King William | 8,380 | Princess Anne | 11,192 |
| Albemarle | 34,920 | Dinwiddie | 15,374 | Lancaster | 8,949 | Prince William | 11,112 |
| Alexandria | 20,959 | Elizabeth City | 19,460 | Lee | 19,856 | Pulaski | 14,609 |
| Alleghany | 16,380 | Essex | 9,701 | Loudoun | 21,948 | Rappahannock | 8,843 |
| Amelia | 9,037 | Fairfax | 18,580 | Louisa | 16,517 | Richmond | 7,088 |
| Amherst | 17,864 | Fauquier | 23,374 | Lunenburg | 11,705 | Roanoke | 37,332 |
| Appomattox | 9,662 | Floyd | 15,388 | Madison | 10,216 | Rockbridge | 24,187 |
| Augusta | 39,659 | Fluvanna | 9,050 | Mathews | 8,239 | Rockingham | 33,527 |
| Bath | 5,595 | Franklin | 25,953 | Mecklenburg | 26,551 | Russell | 18,031 |
| Bedford | 30,356 | Frederick | 18,400 | Middlesex | 8,220 | Scott | 22,694 |
| Bland | 5,497 | Giles | 10,793 | Montgomery | 19,196 | Shenandoah | 20,253 |
| Botetourt | 17,161 | Gloucester | 12,832 | Nansemond | 23,078 | Smyth | 17,121 |
| Brunswick | 18,217 | Goochland | 9,519 | Nelson | 16,075 | Southampton | 22,848 |
| Buchanan | 9,692 | Grayson | 16,853 | New Kent | 4,865 | Spottsylvania | 14,307 |
| Buckingham | 15,266 | Greene | 6,214 | Norfolk | 114,831 | Stafford | 8,097 |
| Campbell | 42,147 | Greenesville | 9,758 | Northampton | 13,770 | Surry | 8,469 |
| Caroline | 16,709 | Halifax | 37,197 | Northumberland | 9,846 | Sussex | 12,082 |
| Carroll | 19,303 | Hanover | 17,618 | Nottoway | 12,366 | Tazewell | 23,384 |
| Charles City | 5,040 | Henrico | 115,112 | Orange | 12,571 | Warren | 8,837 |
| Charlotte | 15,343 | Henry | 19,265 | Page | 13,794 | Warwick | 15,524 |
| Chesterfield | 28,519 | Highland | 5,647 | Patrick | 15,403 | Washington | 33,574 |
| Clarke | 7,927 | Isle of Wight | 13,102 | Pittsylvania | 63,414 | Westmoreland | 9,243 |
| Craig | 4,293 | James City | 5,732 | Powhatan | 6,824 | Wise | 19,653 |
| Culpeper | 14,123 | King and Queen | 9,265 | Prince Edward | 15,045 | Wythe | 20,437 |
| Cumberland | 8,996 | King George | 6,918 | Prince George | 7,752 | York | 7,482 |

Total ..... 1,854,184

## WASHINGTON.

AREA, 69,994 SQUARE MILES.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Adams | 4,840 | Ferry | 4,562 | Lewis | 15,157 | Snohomish | 23,950 |
| Asotin | 3,366 | Franklin | 486 | Lincoln | 11,969 | Spokane | 57,542 |
| Chehalis | 15,124 | Garfield | 3,918 | Mason | 3,810 | Stevens | 10,543 |
| Chelan | 3,931 | Island | 1,870 | Okanogan | 4,689 | Thurston | 9,927 |
| Clallam | 5,603 | Jefferson | 5,712 | Pacific | 5,983 | Wahkiakum | 2,819 |
| Clarke | 13,419 | King | 110,053 | Pierce | 55,515 | Wallawalla | 18,680 |
| Columbia | 7,128 | Kitsap | 6,767 | San Juan | 2,928 | Whatcom | 24,116 |
| Cowlitz | 7,877 | Kittitas | 9,704 | Skagit | 14,272 | Whitman | 25,360 |
| Douglas | 4,926 | Klickitat | 6,407 | Skamania | 1,688 | Yakima | 13,462 |
| Total | | | | | | | 518,103 |

## WEST VIRGINIA.

AREA, 23,000 SQUARE MILES.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Barbour | 14,198 | Hancock | 6,693 | Mineral | 12,883 | Ritchie | 18,901 |
| Berkeley | 19,469 | Hardy | 8,449 | Mingo | 11,359 | Roane | 19,852 |
| Boone | 8,194 | Harrison | 27,690 | Monongalia | 19,049 | Summers | 16,265 |
| Braxton | 18,904 | Jackson | 22,987 | Monroe | 13,130 | Taylor | 14,978 |
| Brooke | 7,219 | Jefferson | 15,935 | Morgan | 7,294 | Tucker | 13,433 |
| Cabell | 29,252 | Kanawha | 54,696 | Nicholas | 11,403 | Tyler | 18,252 |
| Calhoun | 10,266 | Lewis | 16,980 | Ohio | 48,024 | Upshur | 14,696 |
| Clay | 8,248 | Lincoln | 15,434 | Pendleton | 9,167 | Wayne | 23,619 |
| Doddridge | 13,689 | Logan | 6,955 | Pleasants | 9,345 | Webster | 8,862 |
| Fayette | 31,987 | McDowell | 18,747 | Pocahontas | 8,572 | Wetzel | 22,880 |
| Gilmer | 11,762 | Marion | 32,430 | Preston | 22,727 | Wirt | 10,284 |
| Grant | 7,275 | Marshall | 26,444 | Putnam | 17,330 | Wood | 34,452 |
| Greenbrier | 20,683 | Mason | 24,142 | Raleigh | 12,436 | Wyoming | 8,380 |
| Hampshire | 11,806 | Mercer | 23,023 | Randolph | 17,670 | | |
| Total | | | | | | | 958,800 |

## WISCONSIN.

AREA, 53,924 SQUARE MILES.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Adams | 9,141 | Florence | 3,197 | Marathon | 43,256 | Sauk | 33,006 |
| Ashland | 20,176 | Fond du Lac | 47,589 | Marinette | 30,822 | Sawyer | 3,593 |
| Barron | 23,677 | Forest | 1,396 | Marquette | 10,509 | Shawano | 27,475 |
| Bayfield | 14,392 | Grant | 38,881 | Milwaukee | 330,017 | Sheboygan | 50,345 |
| Brown | 46,359 | Green | 22,719 | Monroe | 28,103 | Taylor | 11,262 |
| Buffalo | 16,765 | Green Lake | 15,797 | Oconto | 20,874 | Trempealeau | 23,114 |
| Burnett | 7,478 | Iowa | 23,114 | Oneida | 8,875 | Vernon | 28,351 |
| Calumet | 17,078 | Iron | 6,616 | Outagamie | 46,247 | Vilas | 4,929 |
| Chippewa | 33,037 | Jackson | 17,466 | Ozaukee | 16,363 | Walworth | 29,259 |
| Clark | 25,848 | Jefferson | 34,789 | Pepin | 7,905 | Washburn | 5,821 |
| Columbia | 31,121 | Juneau | 20,629 | Pierce | 23,943 | Washington | 23,589 |
| Crawford | 17,286 | Kenosha | 21,707 | Polk | 17,801 | Waukesha | 35,229 |
| Dane | 69,435 | Kewaunee | 17,212 | Portage | 29,483 | Waupaca | 31,615 |
| Dodge | 46,631 | La Crosse | 42,997 | Price | 9,106 | Waushara | 15,572 |
| Door | 17,583 | Lafayette | 20,959 | Racine | 45,644 | Winnebago | 58,225 |
| Douglas | 36,335 | Langlade | 12,553 | Richland | 19,483 | Wood | 25,865 |
| Dunn | 25,043 | Lincoln | 16,269 | Rock | 51,203 | | |
| Eau Claire | 31,692 | Manitowoc | 42,261 | St. Croix | 26,830 | | |
| Total | | | | | | | 2,069,042 |

## WYOMING.

AREA, 97,883 SQUARE MILES.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Albany | 13,084 | Crook | 3,137 | Natrona | 1,785 | Weston | 3,203 |
| Bighorn | 4,328 | Fremont | 5,357 | Sheridan | 5,122 | Yellowstone Park | 369 |
| Carbon | 9,589 | Johnson | 2,361 | Sweetwater | 8,455 | | |
| Converse | 3,337 | Laramie | 20,181 | Uinta | 12,223 | | |
| Total | | | | | | | 92,531 |

## HOW THE POPULATION OF THE UNITED STATES ARE SHELTERED.*

In the Census year 1900 there were 14,430,145 dwellings, accommodating 16,187,715 families. Of this number 611,435 dwellings accommodated one person each, 10,158,932 sheltered two to six persons, 2,909,687 accommodated seven to ten persons each, and 660,101 eleven persons and over.

* Exclusive of Alaska and Hawaii.

## AREA AND POPULATION OF STATES: 1900.

| State or Territory | Land surface in square miles, 1900. | Rank in population, 1900. | Population 1900. | State or Territory | Land surface in square miles, 1900. | Rank in population, 1900. | Population 1900. |
|---|---|---|---|---|---|---|---|
| United States.. | 3,567,563 | ..... | 76,303,387 | Michigan..... | 57,430 | 9 | 2,420,982 |
| | | | | Minnesota..... | 79,205 | 19 | 1,751,394 |
| Continental U. S..... | 2,970,230 | ..... | 75,994,575 | Mississippi..... | 46,340 | 20 | 1,551,270 |
| | | | | Missouri..... | 68,735 | 5 | 3,106,665 |
| N.Atlantic div | 162,103 | ..... | 21,046,695 | Montana..... | 145,310 | 44 | 243,329 |
| S.Atlantic div. | 268,620 | ..... | 10,443,480 | Nebraska..... | 76,840 | 27 | 1,066,300 |
| N.Central div . | 753,550 | ..... | 26,333,004 | Nevada..... | 109,740 | 52 | 42,335 |
| S.Central div.. | 610,215 | ..... | 14,080,047 | New Hampshire | 9,005 | 36 | 411,588 |
| Western div.. . | 1,175,742 | ..... | 4,091,349 | New Jersey .... | 7,525 | 16 | 1,883,669 |
| | | | | New Mexico.... | 122,460 | 45 | 195,310 |
| | | | | New York..... | 47,620 | 1 | 7,268,894 |
| Alabama..... | 51,540 | 18 | 1,828,697 | North Carolina. | 48,580 | 15 | 1,893,810 |
| Arizona..... | 112,920 | 49 | 122,931 | North Dakota.. | 70,195 | 41 | 319,146 |
| Arkansas..... | 53,045 | 25 | 1,311,564 | Ohio..... | 40,760 | 4 | 4,157,545 |
| California..... | 156,172 | 21 | 1,485,053 | Oklahoma..... | 38,830 | 38 | 398,331 |
| Colorado..... | 103,645 | 31 | 539,700 | Oregon..... | 94,560 | 35 | 413,536 |
| Connecticut.... | 4,845 | 29 | 908,420 | Pennsylvania... | 44,985 | 2 | 6,302,115 |
| Delaware..... | 1,960 | 46 | 184,735 | Rhode Island... | 1,053 | 34 | 428,556 |
| District of Columbia..... | 60 | 42 | 278,718 | South Carolina.. | 30,170 | 24 | 1,340,316 |
| | | | | South Dakota .. | 76,850 | 37 | 401,570 |
| Florida..... | 54,240 | 32 | 528,542 | Tennessee..... | 41,750 | 14 | 2,020,616 |
| Georgia..... | 58,980 | 11 | 2,216,331 | Texas..... | 262,290 | 6 | 3,048,710 |
| Idaho..... | 84,290 | 47 | 161,772 | Utah..... | 82,190 | 43 | 276,749 |
| Illinois..... | 56,000 | 3 | 4,821,550 | Vermont..... | 9,135 | 40 | 343,641 |
| Indiana..... | 35,910 | 8 | 2,516,462 | Virginia..... | 40,125 | 17 | 1,854,184 |
| Indian Territory | 31,000 | 39 | 392,060 | Washington.... | 66,880 | 33 | 518,103 |
| Iowa..... | 55,475 | 10 | 2,231,853 | West Virginia .. | 24,645 | 28 | 958,800 |
| Kansas..... | 81,700 | 22 | 1,470,495 | Wisconsin..... | 54,450 | 13 | 2,069,042 |
| Kentucky..... | 40,000 | 12 | 2,147,174 | Wyoming..... | 97,575 | 50 | 92,531 |
| Louisiana..... | 45,420 | 23 | 1,381,625 | Alaska..... | 590,884 | 51 | 63,592 |
| Maine..... | 29,895 | 30 | 694,466 | Hawaii..... | 6,449 | 48 | 154,001 |
| Maryland..... | 9,860 | 26 | 1,188,044 | Military and naval..... | ..... | ..... | 91,219 |
| Massachusetts.. | 8,040 | 7 | 2,805,346 | | | | |

## POPULATION LIVING IN CITIES WITHIN SPECIFIED LIMITS OF SIZE AND IN COUNTRY DISTRICTS: 1900.

| Divisions. | POPULATION. | | | | | | |
|---|---|---|---|---|---|---|---|
| | Total. | In cities of— | | | | | In country districts. |
| | | At least 100,000. | 25,000 to 100,000. | 8,000 to 25,000. | 4,000 to 8,000. | 2,500 to 4,000. | |
| United States.. | 76,303,387 | 14,208,347 | 5,549,271 | 5,286,375 | 3,380,193 | 2,214,136 | 45,573,846 |
| Continental U. S.... | 75,994,575 | 14,208,347 | 5,509,965 | 5,273,887 | 3,380,193 | 2,211,019 | 45,411,164 |
| N. Atlantic div. | 21,046,695 | 7,533,280 | 2,565,416 | 2,226,013 | 1,289,027 | 738,911 | 6,694,048 |
| S. Atlantic div. | 10,443,480 | 787,675 | 514,353 | 475,098 | 271,894 | 183,112 | 8,210,848 |
| N. Central div. | 26,333,004 | 4,714,117 | 1,383,767 | 1,957,622 | 1,287,707 | 805,714 | 16,184,077 |
| S. Central div. | 14,080,047 | 594,155 | 591,870 | 371,306 | 339,324 | 291,598 | 11,891,794 |
| Western div... | 4,091,349 | 579,120 | 454,059 | 243,848 | 192,241 | 191,684 | 2,430,397 |

## POPULATION OF CITIES HAVING AT LEAST 25,000 INHABITANTS IN 1900.

| Cities. | Rank in population. | Population. | Cities. | Rank in population. | Population. |
|---|---|---|---|---|---|
| Akron, Ohio | 87 | 42,728 | Houston, Tex | 85 | 44,633 |
| Albany, N. Y | 40 | 94,151 | Indianapolis, Ind | 21 | 169,164 |
| Allegheny, Pa | 27 | 129,896 | Jackson, Mich | 161 | 25,180 |
| Allentown, Pa | 114 | 35,416 | Jacksonville, Fla | 143 | 28,429 |
| Altoona, Pa | 97 | 38,973 | Jersey City, N. J | 17 | 206,433 |
| Atlanta, Ga | 43 | 89,872 | Johnstown, Pa | 112 | 35,936 |
| Atlantic City, N. J | 149 | 27,838 | Joliet, Ill | 138 | 29,353 |
| Auburn, N. Y | 135 | 30,345 | Joplin, Mo | 155 | 26,023 |
| Augusta, Ga | 94 | 39,441 | Kansas City, Kans | 76 | 51,418 |
| Baltimore, Md | 6 | 508,957 | Kansas City, Mo | 22 | 163,752 |
| Bay City, Mich | 151 | 27,628 | Knoxville, Tenn | 126 | 32,637 |
| Bayonne, N. J | 125 | 32,722 | LaCrosse, Wis | 141 | 28,895 |
| Binghamton, N. Y | 93 | 39,647 | Lancaster, Pa | 90 | 41,459 |
| Birmingham, Ala | 100 | 38,415 | Lawrence, Mass | 57 | 62,559 |
| Boston, Mass | 5 | 560,892 | Lexington, Ky | 153 | 26,369 |
| Bridgeport, Conn | 54 | 70,996 | Lincoln, Nebr | 91 | 40,169 |
| Brockton, Mass | 92 | 40,063 | Little Rock, Ark | 101 | 38,307 |
| Buffalo, N. Y | 8 | 352,387 | Los Angeles, Cal | 36 | 102,479 |
| Butte, Mont | 133 | 30,470 | Louisville, Ky | 18 | 204,731 |
| Cambridge, Mass | 41 | 91,886 | Lowell, Mass | 39 | 94,969 |
| Camden, N. J | 52 | 75,935 | Lynn, Mass | 55 | 68,513 |
| Canton, Ohio | 132 | 30,667 | McKeesport, Pa | 116 | 34,227 |
| Cedar Rapids, Iowa | 159 | 25,656 | Malden, Mass | 121 | 33,664 |
| Charleston, S. C | 68 | 55,807 | Manchester, N. H | 65 | 56,987 |
| Chattanooga, Tenn | 136 | 30,154 | Memphis, Tenn | 37 | 102,320 |
| Chelsea, Mass | 118 | 34,072 | Milwaukee, Wis | 14 | 285,315 |
| Chester, Pa | 119 | 33,988 | Minneapolis, Minn | 19 | 202,718 |
| Chicago, Ill | 2 | 1,698,575 | Mobile, Ala | 99 | 38,469 |
| Cincinnati, Ohio | 10 | 325,902 | Montgomery, Ala | 134 | 30,346 |
| Cleveland, Ohio | 7 | 381,768 | Nashville, Tenn | 47 | 80,865 |
| Columbus, Ohio | 28 | 125,560 | Newark, N. J | 16 | 246,070 |
| Council Bluffs, Iowa | 158 | 25,802 | New Bedford, Mass | 58 | 62,442 |
| Covington, Ky | 86 | 42,938 | New Britain, Conn | 157 | 25,998 |
| Dallas, Tex | 88 | 42,638 | Newcastle, Pa | 144 | 28,339 |
| Davenport, Iowa | 115 | 35,254 | New Haven, Conn | 31 | 108,027 |
| Dayton, Ohio | 45 | 85,333 | New Orleans, La | 12 | 287,104 |
| Denver, Colo | 25 | 133,859 | Newport, Ky | 145 | 28,301 |
| Des Moines, Iowa | 59 | 62,139 | Newton, Mass | 123 | 33,587 |
| Detroit, Mich | 13 | 285,704 | New York, N. Y.* | 1 | 3,437,202 |
| Dubuque, Iowa | 108 | 36,297 | Norfolk, Va | 80 | 46,624 |
| Duluth, Minn | 72 | 52,969 | Oakland, Cal | 56 | 66,960 |
| Easton, Pa | 160 | 25,238 | Omaha, Nebr | 35 | 102,555 |
| East St. Louis, Ill | 137 | 29,655 | Oshkosh, Wis | 146 | 28,284 |
| Elizabeth, N. J | 74 | 52,130 | Passaic, N. J | 150 | 27,777 |
| Elmira, N. Y | 113 | 35,672 | Paterson, N. J | 32 | 105,171 |
| Erie, Pa | 73 | 52,733 | Pawtucket, R. I | 96 | 39,231 |
| Evansville, Ind | 64 | 59,007 | Peoria, Ill | 67 | 56,100 |
| Fall River, Mass | 33 | 104,863 | Philadelphia, Pa | 3 | 1,293,697 |
| Fitchburg, Mass | 128 | 31,531 | Pittsburg, Pa | 11 | 321,616 |
| Fort Wayne, Ind | 83 | 45,115 | Portland, Me | 78 | 50,145 |
| Fort Worth, Tex | 152 | 26,688 | Portland, Oreg | 42 | 90,426 |
| Galveston, Tex | 103 | 37,789 | Providence, R. I | 20 | 175,597 |
| Gloucester, Mass | 154 | 26,121 | Pueblo, Col | 148 | 28,157 |
| Grand Rapids, Mich | 44 | 87,565 | Quincy, Ill | 109 | 36,252 |
| Harrisburg, Pa | 77 | 50,167 | Racine, Wis | 140 | 29,102 |
| Hartford, Conn | 49 | 79,850 | Reading, Pa | 50 | 78,961 |
| Haverhill, Mass | 105 | 37,175 | Richmond, Va | 46 | 85,050 |
| Hoboken, N. J | 63 | 59,364 | Rochester, N. Y | 24 | 162,608 |
| Holyoke, Mass | 82 | 45,712 | Rockford, Ill | 130 | 31,051 |
| Honolulu, Hawaii | 95 | 39,306 | Sacramento, Cal | 139 | 29,282 |

* The estimated population of the area now embraced in New York city was 2,507,414 in 1890 and 1,911,698 in 1880. Increase 1890 to 1900, 929,788; 1880 to 1890, 595,716. Per cent. of increase 1890 to 1900, 37.1; 1880 to 1890, 31.2.

POPULATION OF CITIES HAVING AT LEAST 25,000 INHABITANTS IN 1900
*Continued.*

| Cities. | Rank in Population. | Population. | Cities. | Rank in Population. | Population. |
|---|---|---|---|---|---|
| Saginaw, Mich. | 89 | 42,345 | Syracuse, N. Y. | 30 | 108,374 |
| St. Joseph, Mo. | 34 | 102,979 | Tacoma, Wash. | 104 | 37,714 |
| St. Louis, Mo. | 4 | 575,238 | Taunton, Mass. | 131 | 31,036 |
| St. Paul, Minn. | 23 | 163,065 | Terre Haute, Ind. | 107 | 36,673 |
| Salem, Mass. | 111 | 35,956 | Toledo, Ohio. | 26 | 131,822 |
| Salt Lake City, Utah. | 70 | 53,531 | Topeka, Kans. | 122 | 33,608 |
| San Antonio, Tex. | 71 | 53,321 | Trenton, N. J. | 53 | 73,307 |
| San Francisco, Cal. | 9 | 342,782 | Troy, N. Y. | 62 | 60,651 |
| Savannah, Ga. | 69 | 54,244 | Utica, N. Y. | 66 | 56,383 |
| Schenectady, N. Y. | 127 | 31,682 | Washington, D. C. | 15 | 278,718 |
| Scranton, Pa. | 38 | 102,026 | Waterbury, Conn. | 81 | 45,859 |
| Seattle, Wash. | 48 | 80,671 | Wheeling, W. Va. | 98 | 38,878 |
| Sioux City, Iowa. | 124 | 33,111 | Wilkesbarre, Pa. | 75 | 51,721 |
| Somerville, Mass. | 61 | 61,643 | Williamsport, Pa. | 142 | 28,757 |
| South Bend, Ind. | 110 | 35,999 | Wilmington, Del. | 51 | 76,508 |
| South Omaha, Nebr. | 156 | 26,001 | Woonsocket, R. I. | 147 | 28,204 |
| Spokane, Wash. | 106 | 36,848 | Worcester, Mass. | 29 | 118,421 |
| Springfield, Ill. | 117 | 34,159 | Yonkers, N. Y. | 79 | 47,931 |
| Springfield, Mass. | 60 | 62,059 | York, Pa. | 120 | 33,708 |
| Springfield, Ohio. | 102 | 38,253 | Youngstown, Ohio. | 84 | 44,885 |
| Superior, Wis. | 129 | 31,091 | | | |

## DEATH RATES FROM CERTAIN CAUSES, FOR THE REGISTRATION AREA, 1900.

| Cause. | Death rate per 100,000. | Cause. | Death rate per 100,000. |
|---|---|---|---|
| Pneumonia | 191.9 | Diseases of the stomach** | 20.0 |
| Consumption* | 190.5 | Diseases of the brain | 18.6 |
| Heart Disease† | 134.0 | Peritonitis | 17.5 |
| Diarrheal diseases‡ | 85.1 | Unknown causes | 16.8 |
| Diseases of the kidneys‖ | 83.7 | Measles | 13.2 |
| Apoplexy | 66.6 | Railroad accidents | 13.2 |
| Cancer | 60.0 | Whooping cough | 12.7 |
| Old age | 54.0 | Suicide | 11.8 |
| Bronchitis | 48.3 | Scarlet fever | 11.5 |
| Cholera infantum | 47.8 | Hydrocephalus | 11.0 |
| Debility and atrophy | 45.5 | Drowning | 11.0 |
| Inflammation of the brain and meningitis | 41.8 | Septicemia | 10.0 |
| Diphtheria | 35.4 | Appendicitis | 9.9 |
| Typhoid fever | 33.8 | Croup | 9.8 |
| Premature birth | 33.7 | Diabetes | 9.4 |
| Convulsions | 33.1 | Burns and scalds | 8.8 |
| Paralysis§ | 32.8 | Malarial fever | 8.8 |
| Inanition | 27.3 | Cerebro-spinal fever | 7.1 |
| Influenza | 23.9 | Dropsy | 6.9 |
| Diseases of the liver¶ | 22.7 | Rheumatism | 6.8 |
| | | Gunshot wounds | 3.8 |

* Including general tuberculosis.

† Including pericarditis.

‡ Including cholera morbus, colitis, diarrhea, dysentery, and enteritis.

‖ Including Bright's disease.

§ Including general paralysis of the insane.

¶ Including jaundice, and inflammation and abscess of the liver.

** Including gastritis.

## FOREIGN BORN POPULATION CLASSIFIED BY PRINCIPAL COUNTRIES OF BIRTH: 1900.

| Country of Birth. | | Country of Birth. | |
|---|---|---|---|
| Austria | 275,907 | Italy | 484,027 |
| Bohemia | 156,891 | Mexico | 103,393 |
| Canada (English) | 784,741 | Norway | 336,388 |
| Canada (French) | 395,066 | Poland | 383,407 |
| China | 81,534 | Russia | 423,726 |
| Denmark | 153,805 | Scotland | 233,524 |
| England | 840,513 | Sweden | 572,014 |
| France | 104,197 | Switzerland | 115,593 |
| Germany | 2,663,418 | Wales | 93,586 |
| Holland | 104,931 | Other countries | 273,442 |
| Hungary | 145,714 | | |
| Ireland | 1,615,459 | Total | 10,341,276 |

## POPULATION AT LEAST 10 YEARS OF AGE ENGAGED IN GAINFUL OCCUPATIONS, CLASSIFIED BY SEX AND SPECIFIED OCCUPATIONS: 1900.

| Occupation. | Total. | Male. | Female. |
|---|---|---|---|
| All occupations | 29,074,117 | 23,754,205 | 5,319,912 |
| Agricultural pursuits | 10,381,765 | 9,404,429 | 977,336 |
| Agricultural laborers | 4,410,877 | 3,747,668 | 663,209 |
| Dairymen and dairywomen | 10,875 | 9,983 | 892 |
| Farmers, planters, and overseers | 5,674,875 | 5,347,169 | 307,706 |
| Gardeners, florists, nurserymen, etc. | 61,788 | 58,928 | 2,860 |
| Lumbermen and raftsmen | 72,020 | 71,920 | 100 |
| Stock raisers, herders, and drovers | 84,988 | 83,056 | 1,932 |
| Turpentine farmers and laborers | 24,737 | 24,456 | 281 |
| Wood choppers | 36,075 | 35,962 | 113 |
| Other agricultural pursuits | 5,530 | 5,287 | 243 |
| Professional service | 1,258,739 | 828,163 | 430,576 |
| Actors, professional showmen, etc | 34,760 | 27,903 | 6,857 |
| Architects, designers, draftsmen, etc | 29,524 | 28,483 | 1,041 |
| Artists and teachers of art | 24,873 | 13,852 | 11,021 |
| Clergymen | 111,638 | 108,265 | 3,373 |
| Dentists | 29,644 | 28,858 | 786 |
| Electricians | 50,717 | 50,308 | 409 |
| Engineers (civil, etc.) and surveyors | 43,239 | 43,155 | 84 |
| Journalists | 30,038 | 27,845 | 2,193 |
| Lawyers | 114,460 | 113,450 | 1,010 |
| Literary and scientific persons | 19,066 | 13,082 | 5,984 |
| Musicians and teachers of music | 92,174 | 39,815 | 52,359 |
| Officials (government)* | 86,607 | 78,488 | 8,119 |
| Physicians and surgeons | 132,002 | 124,615 | 7,387 |
| Teachers and professors in colleges, etc. | 446,133 | 118,519 | 327,614 |
| Other professional service | 13,864 | 11,525 | 2,339 |
| Domestic and personal service | 5,580,657 | 3,485,208 | 2,095,449 |
| Barbers and hairdressers | 131,116 | 125,542 | 5,574 |
| Bartenders | 88,817 | 88,377 | 440 |
| Boarding and lodging house keepers | 71,281 | 11,826 | 59,455 |
| Hotel keepers | 54,797 | 46,264 | 8,533 |
| Housekeepers and stewards | 155,153 | 8,224 | 146,929 |
| Janitors and sextons | 56,577 | 48,544 | 8,033 |
| Laborers (not specified) | 2,629,262 | 2,505,287 | 123,975 |
| Launderers and laundresses | 385,965 | 50,683 | 335,282 |
| Nurses and midwives | 120,956 | 12,265 | 108,691 |
| Restaurant keepers | 33,844 | 28,999 | 4,845 |
| Saloon keepers | 83,746 | 81,660 | 2,086 |
| Servants and waiters | 1,560,721 | 276,958 | 1,283,763 |
| Soldiers, sailors, and marines (United States) | 43,235 | 43,235 | ..... |
| Watchmen, policemen, firemen, etc. | 130,590 | 129,711 | 879 |
| Other domestic and personal service | 34,597 | 27,633 | 6,964 |

*Includes officers of United States Army and Navy.

POPULATION AT LEAST 10 YEARS OF AGE ENGAGED IN GAINFUL OCCUPATIONS, CLASSIFIED BY SEX AND SPECIFIED OCCUPATIONS: 1900—*Continued.*

| Occupation. | Total. | Male. | Female. |
|---|---|---|---|
| Trade and transportation | 4,766,964 | 4,263,617 | 503,347 |
| Agents | 241,162 | 230,606 | 10,556 |
| Bankers and brokers | 73,277 | 72,984 | 293 |
| Boatmen and sailors | 78,406 | 78,253 | 153 |
| Bookkeepers and accountants | 254,880 | 180,727 | 74,153 |
| Clerks and copyists | 630,127 | 544,881 | 85,246 |
| Commercial travelers | 92,919 | 91,973 | 946 |
| Draymen, hackmen, teamsters, etc | 538,933 | 538,029 | 904 |
| Foremen and overseers | 55,450 | 54,032 | 1,418 |
| Hostlers | 64,929 | 64,850 | 79 |
| Hucksters and peddlers | 76,649 | 73,734 | 2,915 |
| Livery stable keepers | 33,656 | 33,466 | 190 |
| Merchants and dealers (except wholesale) | 790,886 | 756,802 | 34,084 |
| Merchants and dealers (wholesale) | 42,293 | 42,032 | 261 |
| Messengers and errand and office boys | 71,622 | 64,959 | 6,663 |
| Officials of banks and companies | 74,072 | 72,801 | 1,271 |
| Packers and shippers | 59,545 | 39,557 | 19,988 |
| Porters and helpers (in stores, etc.) | 54,191 | 53,625 | 566 |
| Salesmen and saleswomen | 611,139 | 461,909 | 149,230 |
| Steam railroad employees | 582,150 | 580,462 | 1,688 |
| Stenographers and typewriters | 112,364 | 26,246 | 86,118 |
| Street railway employees | 68,919 | 68,873 | 46 |
| Telegraph and telephone linemen | 14,757 | 14,757 | ..... |
| Telegraph and telephone operators | 75,015 | 52,459 | 22,556 |
| Undertakers | 16,189 | 15,866 | 323 |
| Other persons in trade and transportation | 53,434 | 49,734 | 3,700 |
| Manufacturing and mechanical pursuits | 7,085,992 | 5,772,788 | 1,313,204 |
| *Building trades.* | | | |
| Carpenters and joiners | 600,252 | 599,707 | 545 |
| Masons (brick and stone) | 160,805 | 160,638 | 167 |
| Painters, glaziers, and varnishers | 277,541 | 275,782 | 1,759 |
| Paper hangers | 21,990 | 21,749 | 241 |
| Plasterers | 35,694 | 35,649 | 45 |
| Plumbers and gas and steam fitters | 97,785 | 97,659 | 126 |
| Roofers and slaters | 9,067 | 9,065 | 2 |
| Mechanics (not otherwise specified) | 9,392 | 9,351 | 41 |
| *Chemicals and allied products.* | | | |
| Oil well and oil works employees | 24,626 | 24,573 | 53 |
| Other chemical workers | 14,814 | 12,035 | 2,779 |
| *Clay, glass, and stone products.* | | | |
| Brick and tile makers, etc | 49,933 | 49,455 | 478 |
| Glass workers | 49,998 | 47,377 | 2,621 |
| Marble and stone cutters | 54,460 | 54,317 | 143 |
| Potters | 16,140 | 13,200 | 2,940 |
| *Fishing and mining.* | | | |
| Fishermen and oystermen | 68,177 | 67,715 | 462 |
| Miners and quarrymen | 563,866 | 562,501 | 1,365 |
| *Food and kindred products.* | | | |
| Bakers | 79,188 | 74,860 | 4,328 |
| Butchers | 113,956 | 113,578 | 378 |
| Butter and cheese makers | 19,241 | 18,593 | 648 |
| Confectioners | 31,194 | 21,980 | 9,214 |
| Millers | 40,548 | 40,362 | 186 |
| Other food preparers | 28,782 | 23,640 | 5,142 |
| *Iron and steel and their products.* | | | |
| Blacksmiths | 226,477 | 226,284 | 193 |
| Iron and steel workers | 290,611 | 287,241 | 3,370 |
| Machinists | 283,145 | 282,574 | 571 |
| Steam boiler makers | 33,046 | 33,038 | 8 |
| Stove, furnace, and grate makers | 12,473 | 12,430 | 43 |
| Tool and cutlery makers | 28,122 | 27,376 | 746 |
| Wheelwrights | 13,505 | 13,495 | 10 |
| Wire workers | 18,487 | 16,701 | 1,786 |

POPULATION AT LEAST 10 YEARS OF AGE ENGAGED IN GAINFUL OCCUPATIONS, CLASSIFIED BY SEX AND SPECIFIED OCCUPATIONS: 1900—*Continued.*

| Occupation. | Total. | Male. | Female. |
|---|---|---|---|
| Manufacturing and mechanical pursuits.—(*Continued*). | | | |
| *Leather and its finished products.* | | | |
| Boot and shoe makers and repairers | 208,912 | 169,393 | 39,519 |
| Harness and saddle makers and repairers | 40,101 | 39,506 | 595 |
| Leather curriers and tanners | 42,671 | 40,917 | 1,754 |
| Trunk and leather-case makers, etc | 7,051 | 5,472 | 1,579 |
| *Liquors and beverages.* | | | |
| Bottlers and soda water makers, etc | 10,519 | 9,725 | 794 |
| Brewers and maltsters | 20,962 | 20,687 | 275 |
| Distillers and rectifiers | 3,144 | 3,114 | 30 |
| *Lumber and its remanufactures.* | | | |
| Cabinetmakers | 35,619 | 35,552 | 67 |
| Coopers | 37,200 | 37,087 | 113 |
| Saw and planing mill employees | 161,624 | 161,251 | 373 |
| Other woodworkers | 111,273 | 104,468 | 6,805 |
| *Metals and metal products other than iron and steel.* | | | |
| Brass workers | 26,760 | 25,870 | 890 |
| Clock and watch makers and repairers | 24,120 | 19,305 | 4,815 |
| Gold and silver workers | 26,112 | 19,732 | 6,380 |
| Tinplate and tinware makers | 70,505 | 68,730 | 1,775 |
| Other metal workers | 56,602 | 54,282 | 2,320 |
| *Paper and printing.* | | | |
| Bookbinders | 30,278 | 14,646 | 15,632 |
| Box makers (paper) | 21,098 | 3,796 | 17,302 |
| Engravers | 11,151 | 10,698 | 453 |
| Paper and pulp mill operatives | 36,328 | 26,904 | 9,424 |
| Printers, lithographers, and pressmen | 155,147 | 139,166 | 15,981 |
| *Textiles.* | | | |
| Bleachery and dye works operatives | 22,278 | 20,493 | 1,785 |
| Carpet factory operatives | 19,388 | 10,371 | 9,017 |
| Cotton mill operatives | 246,004 | 125,788 | 120,216 |
| Hosiery and knitting mill operatives | 47,120 | 12,630 | 34,490 |
| Silk mill operatives | 54,460 | 22,023 | 32,437 |
| Woolen mill operatives | 73,196 | 42,566 | 30,630 |
| Other textile mill operatives | 104,619 | 53,437 | 51,182 |
| Dressmakers | 346,884 | 2,090 | 344,794 |
| Hat and cap makers | 22,733 | 15,110 | 7,623 |
| Milliners | 87,859 | 1,739 | 86,120 |
| Seamstresses | 150,942 | 4,837 | 146,105 |
| Shirt, collar, and cuff makers | 39,432 | 8,491 | 30,941 |
| Tailors and tailoresses | 229,649 | 160,714 | 68,935 |
| Other textile workers | 29,967 | 8,925 | 21,042 |
| *Miscellaneous industries.* | | | |
| Broom and brush makers | 10,220 | 8,643 | 1,577 |
| Charcoal, coke, and lime burners | 14,448 | 14,405 | 43 |
| Engineers and firemen (not locomotive) | 223,495 | 223,318 | 177 |
| Glove makers | 12,271 | 4,503 | 7,768 |
| Manufacturers and officials, etc | 243,082 | 239,649 | 3,433 |
| Model and pattern makers | 15,073 | 14,869 | 204 |
| Photographers | 26,941 | 23,361 | 3,580 |
| Rubber factory operatives | 21,866 | 14,492 | 7,374 |
| Tobacco and cigar factory operatives | 131,452 | 87,955 | 43,497 |
| Upholsterers | 30,821 | 28,663 | 2,158 |
| Other miscellaneous industries | 471,300 | 380,490 | 90,810 |

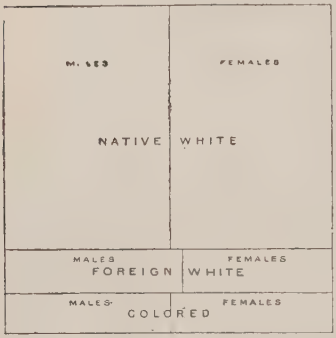
—*From Reports of the Twelfth Census.*

The annals of the Pasteur Institute state that during the year 1902 the number of persons under treatment for hydrophobia in Paris was 1,106, of whom only three died, one of whom had not completed the treatment when he succumbed to hydrophobia; so that in reality there were only two deaths. Of the 1,106 persons under treatment, nine were English, two Spaniards, two Russians, and one each Greek, Dutch, and Swiss—making 16 foreigners to 1,089 French. The diminution in the number of French patients, as compared with several preceding years, is explained by the opening of anti-rabic institutes at Lille, Marseilles, Montpellier, Lyons, and Bordeaux, to one or other of which persons residing in the neighborhood of those towns have been sent instead of going to Paris.

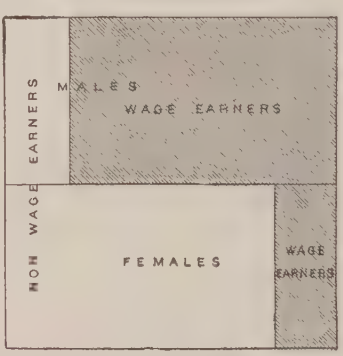
## INDIANS.

In 1902 the area of Indian reservations in the United States was 75,148,643 acres or 117,420 square miles, and the population in 1900 was 270,544, but in 1903 the number had dwindled to 263,233. Indian Territory is occupied by 76,886 Indian inhabitants, while 43,746 live in Arizona and 13,799 in Oklahoma, and 19,477 in South Dakota. The census gives the Indian population in Indian Territory in 1900 as 302,060, and the Indian population elsewhere is included in the census of the States.

DIVISION OF POPULATION BY COLOR.




COMPARISON OF POPULATION BY OCCUPATIONS.




## NUMBER OF PENSIONERS ON THE ROLLS, FIRST PAYMENTS, AND AMOUNTS OF DISBURSEMENTS FOR PENSIONS FROM 1861 TO 1904.

| Year ending June 30— | Number of pensioners on the rolls. | | | Total disbursements. | Cost, maintenance, and expenses. |
|---|---|---|---|---|---|
| | Invalids. | Widows, etc. | Total. | | |
| 1861..... | 4,337 | 4,299 | 8,636 | $1,072,461.55 | ..... |
| 1865..... | 35,880 | 50,106 | 85,986 | 8,525,153.11 | ..... |
| 1868..... | 75,957 | 93,686 | 169,643 | 24,010,981.99 | $553,020.34 |
| 1870..... | 87,521 | 111,165 | 198,686 | 27,780,811.81 | 600,997.86 |
| 1875..... | 122,989 | 111,832 | 234,821 | 29,683,116.63 | 982,695.35 |
| 1880..... | 145,410 | 105,392 | 250,802 | 57,240,540.14 | 935,027.28 |
| 1890..... | 415,654 | 122,290 | 537,944 | 106,493,890.19 | 3,526,382.13 |
| 1900..... | 752,510 | 241,019 | 993,529 | 138,462,130.65 | 3,841,706.74 |
| 1903..... | 729,356 | 267,189 | 996,545 | 137,759,653.71 | 3,993,216.79 |
| 1904..... | 720,921 | 273,841 | 994,762 | 141,093,571.25 | 3,849,366.25 |

The following amounts have been paid to soldiers, their widows, minor children, and dependent relatives on account of military and naval service during the wars in which the United States has been engaged:

| | |
|---|---|
| Revolutionary war (estimated) | $70,000,000.00 |
| War of 1812 (on account of service, without regard to disability) | 45,326,774.16 |
| Indian wars (on account of service, without regard to disability) | 6,980,896.93 |
| War with Mexico (on account of service, without regard to disability) | 35,162,130.35 |
| War of the rebellion | 3,011,373,235.13 |
| War with Spain | 8,586,200.09 |
| Regular Establishment | 2,287,924.99 |
| Actual total disbursements in pensions | $3,179,717,161.65 |

*—Statistical Abstract of the United States.*

## IMMIGRATION.

NUMBER AND NATIONALITY OF IMMIGRANTS ARRIVED IN THE UNITED STATES DURING THE YEARS ENDING JUNE 30, 1889, 1899, AND 1904.

| Countries. | 1889. | 1899. | 1904. |
|---|---|---|---|
| Austria-Hungary: | | | |
| Bohemia | 3,085 | ..... | ..... |
| Hungary | 10,967 | 62,491 | 177,156 |
| Other Austria (except Poland) | 20,122 | ..... | ..... |
| Total | 34,174 | 62,491 | 177,156 |
| Belgium | 2,562 | 1,101 | 3,976 |
| Denmark | 8,699 | 2,690 | 8,525 |
| France | 5,918 | 1,694 | 9,406 |
| Germany | 99,538 | 17,476 | 46,380 |
| Gibraltar | 13 | ..... | ..... |
| Greece | 158 | 2,333 | 11,343 |
| Italy, continental | 24,848 | 77,419 | 193,296 |
| Sicily and Sardinia | 459 | | |
| Malta | ..... | ..... | ..... |
| Netherlands | 6,460 | 1,029 | 4,916 |
| Norway | 13,390 | 6,705 | 23,808 |
| Poland | 4,922 | ..... | ..... |
| Portugal | 57 | 2,054 | 6,715 |
| Roumania | 893 | 1,606 | 7,087 |
| Russia (except Poland*) | 31,889 | 60,982 | 145,141 |
| Finland | 2,027 | | |
| Spain | 526 | 385 | 3,996 |
| Sweden | 35,415 | 12,797 | 27,703 |
| Switzerland | 7,070 | 1,326 | 5,023 |
| Turkey in Europe† | 252 | 132 | 5,669 |
| United Kingdom: | | | |
| England | 68,503 | 10,402 | 38,626 |
| Ireland | 65,557 | 31,673 | 33,142 |
| Scotland | 18,286 | 1,724 | 11,002 |
| Wales | 1,151 | 1,324 | 1,720 |
| Total United Kingdom | 153,537 | 45,123 | 87,590 |

| Countries. | 1889. | 1899. | 1904. |
|---|---|---|---|
| Azores | 1,967 | ..... | ..... |
| Greenland, Iceland and the Faroe Islands | 4 | ..... | ..... |
| Europe not specified | 12 | 6 | 143 |
| Total Europe | 434,790 | 297,349 | 767,933 |
| British North America | ‡ | 1,322 | 2,837 |
| Mexico | ‡ | 161 | 1,009 |
| Central America | 88 | 159 | 714 |
| Bermuda | 21 | ..... | ..... |
| West Indies and Miquelon | 4,923 | 2,585 | 10,193 |
| South America | 427 | 89 | 1,667 |
| Total America | ‡5,459 | 4,316 | 16,420 |
| China | 118 | 1,660 | 4,309 |
| Japan | 640 | 2,844 | 14,264 |
| Other Asia | 967 | 4,468 | 7,613 |
| Total Asia | 1,725 | 8,972 | 26,186 |
| Total Oceania | 2,196 | ..... | 1,555 |
| Total Africa | 187 | 51 | 686 |
| All other countries | 70 | 1,027 | 90 |
| Total immigrants | 444,427 | 311,715 | 812,870 |

* Poland included in 1899 and 1904.
† Includes Servia, Bulgaria, and Montenegro.
‡ Immigrants from British North America and Mexico not reported.

—*Statistical Abstract of United States.*

## LABOR'S DEATH ROLL.

No less than 4,513 lives were lost in 1902 while in the ordinary pursuit of their calling in the United Kingdom. 112,133 persons were injured in the same period. The percentage of deaths from different causes in coal mining was (1) On the surface, 11.3; (2) Miscellaneous underground, 28.3; (3) In the shafts, 9.9; (4) By falls of ground, 44.1; (5) By explosions, 6.4.

| | Number Employed According to Latest Returns. | Killed. | | Injured. | |
|---|---|---|---|---|---|
| | | 1898. | 1902. | 1898. | 1902. |
| Factories | 3,929,213 | 575 | 837 | 49,290 | 77,118 |
| Mines | 855,603 | 941 | 1,053 | 4,408 | 3,999 |
| Quarries | 97,108 | 134 | 119 | 1,434 | 1,190 |
| Shipping (Merchant Vessels) | 230,161 | 1,139 | 1,397 | 2,354 | 2,228 |
| Railway service | 575,834 | 522 | 468 | 12,826 | 13,735 |
| Workshops | Cannot be stated. | 2 | 9 | 135 | 224 |
| Laundries | | ..... | 1 | 217 | 355 |
| Docks, wharves, and quays | | 89 | 129 | 4,070 | 4,906 |
| Warehouses | | 16 | 42 | 2,507 | 4,235 |
| Buildings | | 45 | 89 | 616 | 2,412 |
| Railway service (contractors' servants) | | 20 | 17 | 153 | 123 |
| Under notice of Accidents Act, 1894 | | 56 | 62 | 1,491 | 1,451 |
| Shipping (Fishing vessels, etc.) | | 271 | 290 | 132 | 157 |
| Total | | 3,810 | 4,513 | 79,633 | 112,133 |

—"*Daily Mail*" *Year Book.*

THE TIDE OF IMMIGRATION—STATUS IN 1889.

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THE TIDE OF IMMIGRATION—STATUS IN 1903.

ITALY 230,622.

AUSTRIA 206,011.

RUSSIA 136,093.

GERMANY 40,086.

SWEDEN 46,028.

IRELAND 35,310.

ENGLAND 26,219

NORWAY 24,461.

JAPAN 19,968.

GREECE 14,090.

PORTUGAL 9,317.

ROUMANIA 8,310.

WEST INDIES 8,170.

DENMARK 7,158.

SCOTLAND 6,143.

FRANCE 5,578.

NETHERLANDS 3,998.

SWITZERLAND 3,883.

BELGIUM 3,450.

TURKEY 3,290.

CHINA 2,208

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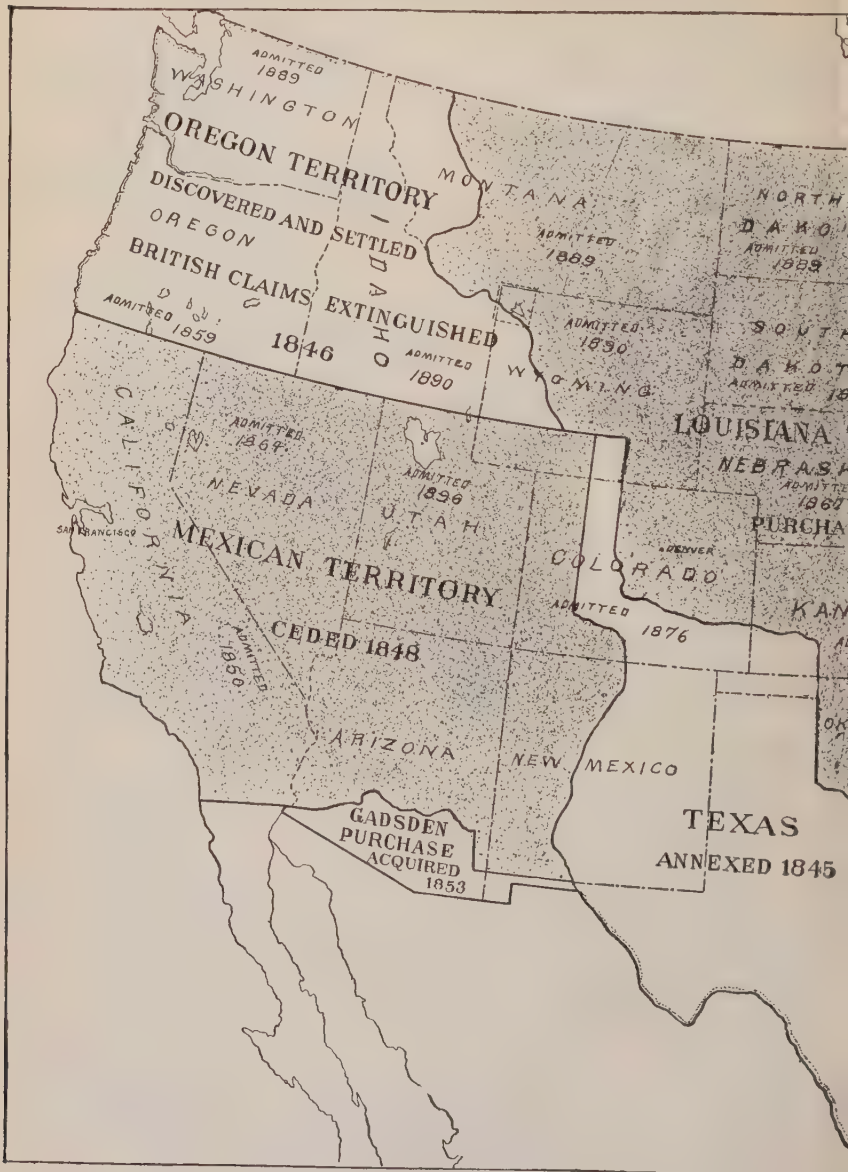


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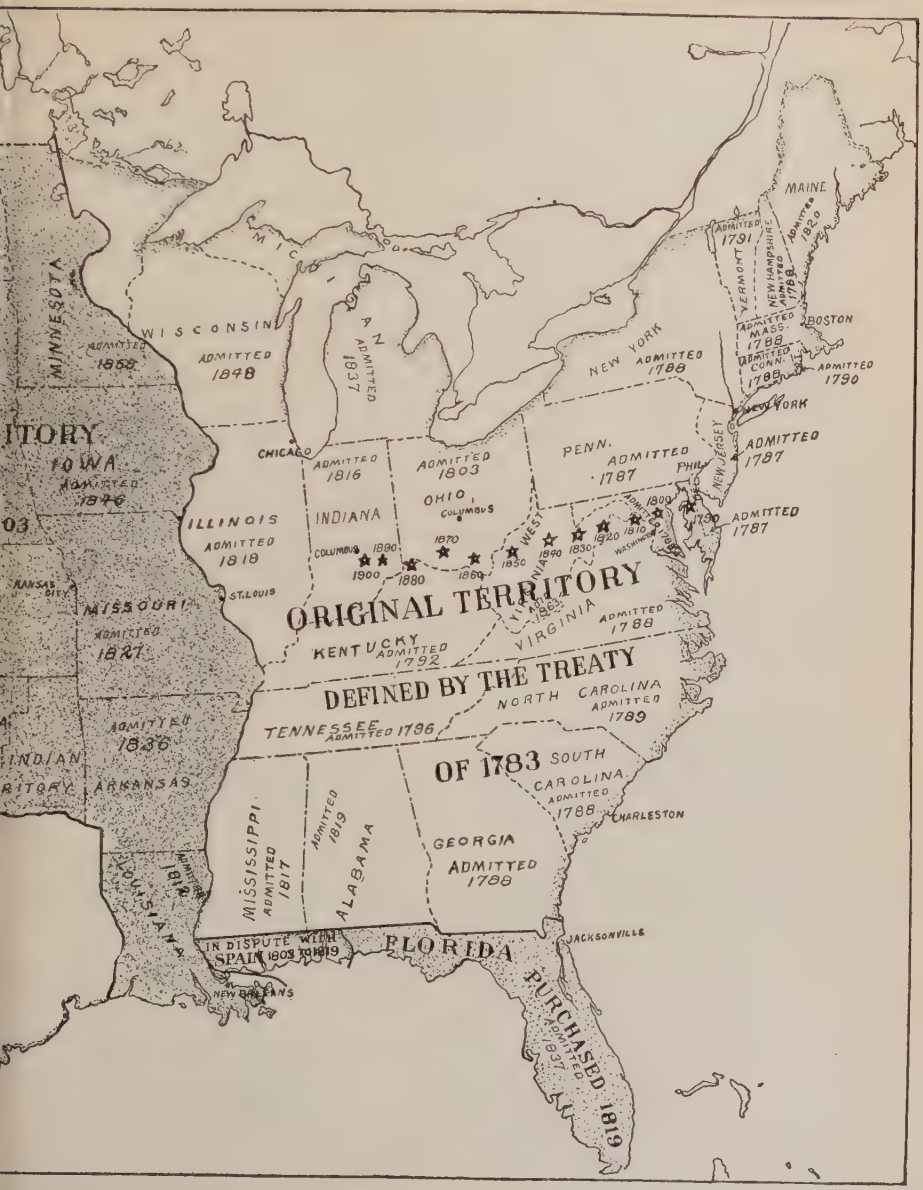


CENTER OF POPULATION, 1790–1900.

pulation at different periods.

## TERRITORIAL EXPANSION.

There have been sixteen additions to the original territory of the Union, including Alaska, the Hawaiian, Philippine and Samoan Islands and Guam, in the Pacific, and Porto Rico, in the West Indies; and the Panama strip; and the total area of the United States, including the noncontiguous territory, is now fully five times that of the original thirteen colonies.

The additions to the territory of the United States subsequent to the peace treaty with Great Britain of 1783, are shown by the following table, prepared by the General Land Office of the Interior Department:

ADDITIONS TO THE TERRITORY OF THE UNITED STATES FROM 1800 TO 1904.

| Territorial Division. | Year. | Area added. | Purchase price. |
|---|---|---|---|
| | | *Square miles.* | *Dollars.* |
| Louisiana purchase | 1803 | 875,025 | 15,000,000 |
| Florida | 1819 | 70,107 | *6,489,768 |
| Texas | 1845 | 389,795 | ..... |
| Oregon Territory | 1846 | 288,689 | ..... |
| Mexican cession | 1848 | 523,802 | †18,250,000 |
| Purchase from Texas | 1850 | (‡) | 10,000,000 |
| Gadsden purchase | 1853 | 36,211 | 10,000,000 |
| Alaska | 1867 | 599,446 | 7,200,000 |
| Hawaiian Islands | 1897 | 6,740 | ..... |
| Porto Rico | 1898 | 3,600 | ..... |
| Guam | 1898 | 175 | ..... |
| Philippine Islands | 1899 | 143,000 | 20,000,000 |
| Samoan Islands | 1899 | 73 | ..... |
| Additional Philippines | 1901 | 68 | 100,000 |
| Panama Canal | 1903 | ..... | 40,000,000 |
| Panama Canal strip | 1904 | ..... | 10,000,000 |
| Total | ..... | 2,936,731 | 137,039,768 |

* Includes interest payment.

† Of which $3,250,000 was in payment of claims of American citizens against Mexico.

‡ Area purchased from Texas amounting to 123,784 square miles is not included in the column of area added, because it became a part of the area of the United States with the admission of Texas.

## AREA AND POPULATION OF THE UNITED STATES.

The following table, published by the United States Census Office, shows the gross area and population of the United States at each of the decennial censuses from 1790 to 1900, exclusive of all noncontiguous territory.

| Year. | Area. | Population. | Year. | Area. | Population. |
|---|---|---|---|---|---|
| | *Square miles.* | | | *Square miles.* | |
| 1790 | 827,844 | 3,929,214 | 1850 | 2,980,959 | 23,191,876 |
| 1800 | 827,844 | 5,308,483 | 1860 | 3,025,600 | 31,443,321 |
| 1810 | 1,999,775 | 7,239,881 | 1870 | 3,025,600 | 38,558,371 |
| 1820 | 2,059,043 | 9,633,453 | 1880 | 3,025,600 | 50,155,783 |
| 1830 | 2,059,043 | 12,866,020 | 1890 | 3,025,600 | 62,622,250 |
| 1840 | 2,059,043 | 17,069,453 | 1900 | 3,025,600 | 75,994,575 |

# CHAPTER VII.

## EDUCATION, LIBRARIES, PRINTING AND PUBLISHING.

### THE VALUE OF AN EDUCATION.

In the annual report of the United States Commissioner of Education appears a sheet of statistics showing to what extent higher education affects success in life. Particularly it shows the pre-eminence of the A.B. degree man among the successful, and the inconspicuousness of the self-educated.

The standard of success to which the educational statistics are applied is that which constitutes eligibility to the ranks of the 10,000 or so persons included in "Who's Who in America" —that is, according to the editors, "the most notable in all departments of usefulness and reputable endeavor." These men have all reported the scope and method of their education.

The United States Bureau of Education divides the 14,794,403 males over 30 years old in the United States according to the last census into four educational classes, as follows:

| | |
|---|---|
| Class I. Without education | 1,757,023 |
| Class II. With only common school training or trained outside of organized schools | 12,054,335 |
| Class III. With regular high school training added | 657,432 |
| Class IV. With college or higher education added | 325,613 |

Omitting those few who are under 30 years old, says this report, the statements from 10,704 notables show that they include: Without education, none; self-taught, 24; home taught, 278; with common school training only, 1,066; with high school training, 1,627; with college training, 7,709, of whom 6,129 were graduates. That is:

From 1800 to 1870 the uneducated boy in the United States failed entirely to become so notable in any department of usefulness and reputable endeavor as to attract the attention of the "Who's Who" editors, and that only 24 self-taught men succeeded.

A boy with only a common school education had, in round numbers, one chance in 9,000.

A high school training increased this chance nearly twenty-two times.

College education added gave the young man about ten times the chance of a high school boy and 200 times the chance of the boy whose training stopped with the common school.

The A.B. graduate was pre-eminently successful, and the self-educated man was inconspicuous.

"From the nature of the case," concludes the compiler, "it cannot be claimed that these classifications are exact, but they are based upon the fullest statistics ever obtained, and the necessary estimates have been made by government experts. It is also doubtless true that other circumstances contributed to the success of these trained men, but after all reasonable allowances are made the figures force the conclusion that the more school training the American boy of that period had, the greater were his chances of distinction.

"It is unnecessary to extend this inquiry to woman," he says, in conclusion. "Education is practically her only door to eminence."

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Professor Ramsay, of University College, London, in a letter to the "Times," points out the remarkable part which Technical Education plays in German trade.

"A German company employs no fewer than 70 chemists; it is one which manufactures no product of which it sells less than one hundred tons a year. Of the seventy chemists required, 20 are employed in analyzing the raw materials and intermediate and finished products; 25 are engaged in superintending the processes of manufacture, and the remaining 25 are exclusively employed in scientific work to improve the present processes of manufacture." —*Daily Mail Year Book.*

## NUMBER OF PUPILS AND STUDENTS OF ALL GRADES IN BOTH PUBLIC AND PRIVATE SCHOOLS AND COLLEGES, 1903-4.

NOTE.—The classification of States made use of in the following table is the same as that adopted by the United States census, and is as follows: *North Atlantic Division:* Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, and Pennsylvania. *South Atlantic Division:* Delaware, Maryland, District of Columbia, Virginia, West Virginia, North Carolina, South Carolina, Georgia, and Florida. *South Central Division:* Kentucky, Tennessee, Alabama, Mississippi, Louisiana, Texas, Arkansas, Oklahoma, and Indian Territory. *North Central Division:* Ohio, Indiana, Illinois, Michigan, Wisconsin, Minnesota, Iowa, Missouri, North Dakota, South Dakota, Nebraska, and Kansas. *Western Division:* Montana, Wyoming, Colorado, New Mexico, Arizona, Utah, Nevada, Idaho, Washington, Oregon, and California.

| Division. | Pupils Receiving Elementary Instruction (Primary and Grammar Grades). | | Pupils Receiving Secondary Instruction (High-school Grades).[1] | | Students Receiving Higher Instruction. | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | In Universities and Colleges.[3] | | | In Schools of Medicine, Law, and Theology.[5] | | | In Normal Schools.[7] | | | Total Higher. | |
| | Public. | Private (largely estimated). | Public.[2] | Private (in Preparatory Schools, Academies, Seminaries, etc.). | Public.[4] | Private. | Total. | Public.[6] | Private. | Total. | Public. | Private. | Total. | Public. | Private. |
| The United States | 15,620,230 | 1,200,813 | 652,804 | 169,431 | 44,209 | 84,552 | 128,761 | 10,565 | 50,659 | 61,224 | 51,635 | 11,992 | 863,627 | 106,409 | 147,203 |
| N. Atlantic Div. . . | 3 636,898 | 439,467 | 211,304 | 51,477 | 5,946 | 34,957 | 40,903 | 399 | 17,425 | 17,824 | 19,421 | 1,258 | 20,679 | 25,766 | 53,640 |
| S. Atlantic Div. . . | 2,291,278 | 104,271 | 36,039 | 23,970 | 5,767 | 10,955 | 16,722 | 1,532 | 6,845 | 8,377 | 4,250 | 1,021 | 5,271 | 11,549 | 18,821 |
| S. Central Div. . . . | 3,185,954 | 123,235 | 52,152 | 29,731 | 4,227 | 10,296 | 14,523 | 1,192 | 6,616 | 7,808 | 4,446 | 2,848 | 7,294 | 9,865 | 19,760 |
| N. Central Div. . . | 5,595,279 | 475,060 | 304,439 | 51,751 | 21,845 | 24,434 | 46,279 | 6,623 | 18,233 | 24,856 | 19,614 | 6,843 | 26,457 | 48,082 | 49,510 |
| Western Division.. | 910,821 | 58,780 | 48,870 | 12,502 | 6,424 | 3,910 | 10,334 | 819 | 1,540 | 2,359 | 3,904 | 22 | 3,926 | 11,147 | 5,472 |

| Division | Summary of Pupils by Grade. | | | Summary According to Control. | | Grand Total. | Per Cent. in Each Grade of the Whole Number of Pupils. | | | Per Cent. of Public Pupils. | | | Per Cent. of the Total Population Enrolled in Each Grade. | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Elementary. | Secondary. | Higher | Public. | Private. | | Elementary. | Secondary. | Higher. | Elementary. | Secondary. | Higher. | Elementary. | Secondary. | Higher. | Total. |
| The United States. . | 16,821,043 | 822,235 | 253,612 | 16,379,443 | 1,517,447 | 17,896,890 | 93.99 | 4.59 | 1.42 | 92.86 | 79.40 | 41.96 | 20.71 | 1.01 | 0.31 | 22.03 |
| N. Atlantic Division. | 4,076,365 | 262,781 | 79,406 | 3,873,968 | 544,584 | 4,418,552 | 92.26 | 5.95 | 1.79 | 89.22 | 80.41 | 32.45 | 18.12 | 1.17 | 0.35 | 19.64 |
| S. Atlantic Division.. | 2.395,549 | 60,009 | 30,370 | 2,338,866 | 147,062 | 2,485,928 | 96.36 | 2.42 | 1.22 | 95.65 | 60.06 | 38.03 | 21.62 | 0.54 | 0.27 | 22.43 |
| S. Central Division. . | 3,309,189 | 81,883 | 29,625 | 3,247,971 | 172,726 | 3,420,697 | 96.74 | 2.39 | 0.87 | 96.28 | 63.69 | 33.20 | 21.71 | 0.54 | 0.19 | 22.44 |
| N. Central Division . | 6,070,339 | 356,190 | 97,592 | 5,947,800 | 576,321 | 6,524,121 | 93.05 | 5.46 | 1.49 | 92.17 | 85.47 | 49.27 | 21.74 | 1.27 | 0.35 | 23.36 |
| Western Division... | 969,601 | 61,372 | 16,619 | 970,838 | 76,754 | 1,047,592 | 92.55 | 5.86 | 1.59 | 93.94 | 79.63 | 67.07 | 21.60 | 1.37 | 0.37 | 23.34 |

[1] Including pupils in preparatory or academic departments of higher institutions, public and private, and excluding elementary pupils who are classed in columns 2 and 3.

[2] This is made up from the returns of individual high schools to the Bureau, and is somewhat too small, as there are many secondary pupils outside the completely organized high schools whom there are no means of enumerating.

[3] Including colleges for women, agricultural and mechanical (land-grant) colleges, and scientific schools. Students in law, theological, and medical departments are excluded, being tabulated in columns 9–11. Students in academic and preparatory departments are also excluded, being tabulated in columns 4 and 5.

[4] Mainly State universities and agricultural and mechanical colleges.

[5] Including also schools of dentistry, pharmacy, and veterinary medicine.

[6] Mainly in schools or departments of medicine and law attached to State universities.

[7] Non-professional pupils in normal schools are included in columns 4 and 5

[8] There are, in addition to this number, 23,612 students taking normal courses in universities, colleges, and public and private high schools.

## POPULATION, ENROLLMENT, AVERAGE DAILY ATTENDANCE, NUMBER, AND SEX OF TEACHERS.

| Division. | Estimated Total Population in 1904. | Pupils Enrolled in the Elementary and Secondary Common Schools. | Per Cent. of the Population Enrolled | Average Daily Attendance. | Number of Teachers. | | |
|---|---|---|---|---|---|---|---|
| | | | | | Male. | Female. | Total. |
| The United States. . . . | 81,241,246 | 16,256,038 | 20.01 | 11,318,256 | 113,744 | 341,498 | 455,242 |
| North Atlantic Division . | 22,502,587 | 3,843,908 | 17.08 | 2,866,074 | 17,283 | 95,873 | 113,156 |
| South Atlantic Division.. | 11,077,704 | 2,324,906 | 20.99 | 1,503,917 | 18,332 | 34,191 | 52,523 |
| South Central Division. . | 15,244,015 | 3,235,121 | 21.22 | 2,074,304 | 28,654 | 40,149 | 68,803 |
| North Central Division. . | 27,927,947 | 5,895,631 | 21.11 | 4,188,517 | 43,678 | 148,606 | 192,284 |
| Western Division. . . . . | 4,488,993 | 956,472 | 21.31 | 685,444 | 5,797 | 22,679 | 28,476 |

## AVERAGE NUMBER OF DAYS TAUGHT, SALARIES OF TEACHERS, VALUE OF SCHOOL PROPERTY, AND REVENUE FROM VARIOUS SOURCES, 1903-4.

| Division. | Average Number of Days the Schools were Kept. | Average Monthly Salaries of Teachers. | | Value of Public School Property. | Raised from State Taxes. | Raised from Local Taxes. | Raised from Other Sources, State and Local, etc. (including from Permanent Funds.) |
|---|---|---|---|---|---|---|---|
| | | Males. | Females. | | | | |
| The United States. . | 146 7 | $50.96 | $41.54 | $685,101,343 | $42,552,969 | $193,215,794 | $43,365,232 |
| North Atlantic Div. | 176.5 | 67.55 | 43.57 | 279,218,286 | 14,030,160 | 78,439,500 | 20,029,248 |
| S. Atlantic Div. . . . | 117.2 | 32.12 | 29.51 | 28,615,462 | 5,235,716 | 8,285,395 | 2,264,080 |
| S. Central Division.. | 107.9 | 43.51 | 35.77 | 38,382,145 | 7,657,635 | 8,036,705 | 4,039,056 |
| N. Central Division.. | 156.0 | 54.54 | 42.30 | 278,382,058 | 9,152,171 | 84,146,463 | 14,515,745 |
| Western Division. . . | 147.9 | 70.98 | 56.42 | 60,503,392 | 6,477,287 | 14,307,791 | 2,517,103 |

### Statistics of City School Systems, 1903-4.

## ENROLLMENT, AVERAGE ATTENDANCE, LENGTH OF SCHOOL TERM, NUMBER OF TEACHERS, AND EXPENDITURES IN CITIES OF 8,000 INHABITANTS AND OVER.

| Division. | Number of City School Systems. | Enrollment in Public Day Schools. | Average Daily Attendance. | Average Length of School Term. | Number of Teachers and Supervisors. | | Expenditure for Supervision and Teaching. | Expenditure for all Purposes (Payment of Loans and Bonds Excepted). |
|---|---|---|---|---|---|---|---|---|
| | | | | | Male. | Female. | | |
| United States. . . | 588 | 4,374,463 | 3,354,806 | 187.9 | 10,088 | 92,155 | $74,332,482 | $129,836,203 |
| N. Atlantic Div. . | 242 | 2,132,257 | 1,632,457 | 189.9 | 4,655 | 45,488 | 39,659,919 | 70,617,085 |
| S. Atlantic Div. . | 45 | 297,272 | 217,325 | 182.1 | 770 | 5,897 | 3,845,343 | 5,371,379 |
| S. Central Div. . . | 52 | 243,977 | 178,689 | 179.8 | 650 | 5,294 | 2,890,879 | 4,356,941 |
| N. Central Div. . | 211 | 1,422,568 | 1,112,693 | 187.5 | 3,292 | 30,174 | 22,695,382 | 40,057,112 |
| Western Div. . . . | 38 | 278,389 | 213,642 | 188.2 | 721 | 5,952 | 5,240,959 | 9,433,686 |

## Statistics of Secondary Education, 1903-4.

### INSTRUCTORS AND STUDENTS IN PUBLIC HIGH SCHOOLS AND IN PRIVATE HIGH SCHOOLS AND ACADEMIES.

| Division. | Public High Schools. | | | | | Private Secondary Schools. | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Number. | Secondary Teachers. | | Secondary Students. | | Number. | Secondary Teachers. | | Secondary Students. | |
| | | Male. | Female. | Male. | Female. | | Male. | Female. | Male. | Female. |
| United States... | 7,230 | 12,825 | 13,935 | 266,039 | 369,769 | 1,606 | 4,051 | 5,515 | 51,599 | 51,808 |
| N. Atlantic Div.. | 1,635 | 3,467 | 5,141 | 88,690 | 118,320 | 589 | 1,837 | 2,351 | 21,658 | 18,634 |
| S. Atlantic Div.. | 507 | 822 | 696 | 13,624 | 20,004 | 284 | 648 | 853 | 8,381 | 7,927 |
| S. Central Div... | 771 | 1,175 | 895 | 19,764 | 29,403 | 293 | 531 | 663 | 8,831 | 9,071 |
| N. Central Div... | 3,895 | 6,462 | 6,185 | 125,110 | 175,242 | 322 | 743 | 1,234 | 9,248 | 12,063 |
| Western Div. ... | 422 | 899 | 1,018 | 18,851 | 26,800 | 118 | 292 | 414 | 3,481 | 4,113 |

## Statistics of Higher Education, 1903-4.

### INSTRUCTORS AND STUDENTS IN PUBLIC AND PRIVATE NORMAL SCHOOLS OF THE UNITED STATES.

| Division. | Public Normal Schools. | | | | | Private Normal Schools. | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Number. | Teachers of Normal Students. | | Students in Normal Course. | | Number. | Teachers of Normal Students. | | Students in Normal Course. | |
| | | Male. | Female. | Male. | Female. | | Male. | Female. | Male. | Female. |
| United States..... | 178 | 1,145 | 1,701 | 11,381 | 40,254 | 91 | 346 | 322 | 5,368 | 6,624 |
| N. Atlantic Div.. .. | 62 | 360 | 728 | 3,279 | 16,142 | 6 | 24 | 76 | 290 | 968 |
| S. Atlantic Div. ... | 25 | 122 | 201 | 1,035 | 3,215 | 24 | 33 | 68 | 297 | 724 |
| S. Central Division | 23 | 130 | 132 | 1,467 | 2,979 | 26 | 74 | 76 | 1,521 | 1,327 |
| N. Central Division | 47 | 396 | 480 | 4,950 | 14,664 | 34 | 212 | 99 | 3,256 | 3,587 |
| Western Division.. | 21 | 137 | 160 | 650 | 3,254 | 1 | 3 | 3 | 4 | 18 |

### INSTRUCTORS AND STUDENTS IN COEDUCATIONAL COLLEGES AND UNIVERSITIES AND IN COLLEGES FOR MEN ONLY, 1903-4.

| Division. | Number of Institutions. | Professors and Instructors. | | Students. | | | | | | Total Income. |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Preparatory. | | Collegiate. | | Resident Graduate. | | |
| | | Male. | Female. | Male. | Female. | Male. | Female. | Male. | Female. | |
| United States. | 443 | 10,200 | 2,193 | 35,620 | 16,519 | 67,475 | 22,839 | 4,342 | 1,574 | $29,278,516 |
| N. Atlan. Div. | 83 | 3,344 | 200 | 7,887 | 1,457 | 25,324 | 3,377 | 1,920 | 487 | 10,573,719 |
| S. Atlan. Div. | 70 | 1,055 | 198 | 3,965 | 1,869 | 6,792 | 1,016 | 447 | 19 | 2,675,067 |
| S. Central Div | 69 | 956 | 368 | 6,094 | 3,227 | 6,584 | 2,260 | 150 | 51 | 2,201,150 |
| N. Central Div | 184 | 3,966 | 1,222 | 14,571 | 7,685 | 23,800 | 12,941 | 1,499 | 813 | 10,816,717 |
| Western Div.. | 37 | 879 | 205 | 3,103 | 2,281 | 4,975 | 3,245 | 326 | 204 | 3,011,862 |

## INSTRUCTORS AND STUDENTS IN SCHOOLS OF TECHNOLOGY AND INSTITUTIONS CONFERRING ONLY THE B. S. DEGREE, 1903-4.

| Division. | Number of Institutions. | Professors and Instructors. | | Students. | | | | | | Total Income. |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Preparatory. | | Collegiate | | Resident Graduate. | | |
| | | Male. | Female. | Male. | Female. | Male. | Female. | Male. | Female. | |
| United States. | 43 | 1,586 | 161 | 3,288 | 804 | 13,997 | 1,237 | 192 | 32 | $6,838,226 |
| N. Atlan. Div. | 10 | 439 | 14 | 60 | 39 | 3,403 | 86 | 30 | 0 | 2,608,471 |
| S. Atlan. Div. | 8 | 295 | 0 | 272 | 0 | 3,284 | 3 | 34 | 0 | 980,841 |
| S. Cent. Div | 5 | 159 | 7 | 781 | 189 | 1,352 | 94 | 27 | 0 | 663,413 |
| N. Cent. Div. | 11 | 468 | 93 | 1,361 | 308 | 4,875 | 727 | 78 | 27 | 1,834,283 |
| Western Div | 9 | 225 | 47 | 814 | 268 | 1,086 | 327 | 23 | 5 | 751,218 |

## INSTRUCTORS AND STUDENTS IN COLLEGES AND SEMINARIES FOR WOMEN WHICH CONFER DEGREES, 1903-4.

| Division. | Number of Institutions. | Professors and Instructors. | | Female Students. | | | Total Income. |
|---|---|---|---|---|---|---|---|
| | | Male. | Female. | Preparatory. | Collegiate. | Graduate. | |
| United States | 121 | 631 | 1,834 | 4,800 | 16,031 | 344 | $4,212,451 |
| North Atlantic Div. | 19 | 292 | 484 | 1,025 | 5,858 | 224 | 2,027,920 |
| South Atlantic Div. | 42 | 183 | 522 | 1,155 | 5,052 | 45 | 876,253 |
| South Central Div. | 42 | 103 | 520 | 1,338 | 3,923 | 45 | 717,969 |
| North Central Div. | 16 | 46 | 257 | 1,060 | 1,121 | 24 | 526,709 |
| Western Division. | 2 | 7 | 51 | 222 | 77 | 6 | 63,600 |

## SUMMARY OF STATISTICS OF PROFESSIONAL SCHOOLS FOR 1903-4.

| Division. | Theological. | | | Law. | | | Medical. | | |
|---|---|---|---|---|---|---|---|---|---|
| | Schools. | Instructors. | Students. | Schools. | Instructors. | Students. | Schools. | Instructors. | Students. |
| United States. | 153 | 1,055 | *7,392 | 95 | 1,167 | †14,306 | 152 | 5,252 | 26,949 |
| N. Atlantic Division. | 51 | 453 | 2,636 | 17 | 270 | 4,875 | 25 | 1,048 | 6,363 |
| S. Atlantic Division. | 21 | 122 | 822 | 20 | 170 | 2,133 | 24 | 602 | 3,868 |
| S. Central Division | 14 | 70 | 626 | 15 | 97 | 834 | 28 | 644 | 5,320 |
| N. Central Division. | 61 | 381 | 3,195 | 37 | 558 | 5,937 | 63 | 2,577 | 10,386 |
| Western Division | 6 | 29 | 113 | 6 | 72 | 527 | 12 | 381 | 1,012 |

* 187 of these were women.

† 163 of these were women.

## GENERAL SUMMARY OF STATISTICS OF PROFESSIONAL AND ALLIED SCHOOLS FOR 1903-4.

| Class. | Schools. | Instructors. | Students. | Graduates. |
|---|---|---|---|---|
| Theological | 153 | 1,055 | 7,392 | 1,620 |
| Law | 95 | 1,167 | 14,306 | 3,288 |
| Medical | 152 | 5,252 | 26,949 | 5,702 |
| Dental | 54 | 1,191 | 7,325 | 2,192 |
| Pharmaceutical | 63 | 611 | 4,457 | 1,308 |
| Veterinary | 11 | 165 | 795 | 198 |
| Nurse training | 724 | ..... | 17,713 | 5,333 |
| Total | 1,252 | 9,441 | 78,937 | 19,641 |
| Medical schools included above: | | | | |
| Regular | 122 | 4,253 | 24,694 | 5,184 |
| Homeopathic | 19 | 666 | 1,289 | 368 |
| Eclectic and physio-medical | 11 | 333 | 966 | 150 |
| Total | 152 | 5,252 | 26,949 | 5,702 |

## ENROLLMENT IN SPECIAL SCHOOLS IN 1903-4.

| | |
|---|---|
| City evening schools | 270,692 |
| Business schools | 138,363 |
| Schools for defectives | 32,098 |
| Reform schools | 33,871 |
| Government Indian schools | 29,161 |
| Indian schools (five civilized tribes) | 13,727 |
| Schools in Alaska supported by the Government | 2,257 |
| Schools in Alaska supported by incorporated municipalities (partly estimated) | 2,000 |
| Orphan asylums and other benevolent institutions | 15,000 |
| Private kindergartens (estimated) | 105,932 |
| Miscellaneous (including schools of music, oratory, elocution, cookery, and various special arts (estimated) | 50,000 |
| Total | 693,101 |

## SUMMARY OF STATISTICS OF PUBLIC, SOCIETY, AND SCHOOL LIBRARIES OF 1,000 VOLUMES AND OVER IN 1903.

### NUMBER OF PERIODICALS AND PAMPHLETS, VOLUMES ADDED, AND BOOKS ISSUED.

| Division. | Periodicals. | | Pamphlets | | Volumes Added During the Year. | | Books Issued for Home Use. | | Books Issued for Use in Library. | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Libraries Reporting. | Number. | Libraries Reporting. | Number. | Libraries Reporting. | Number. | Libraries Reporting. | Number. | Libraries Reporting. | Number. |
| United States | 3,248 | 186,880 | 6,869 | 9,314,943 | 4,464 | 2,563,550 | 2,988 | 59,188,407 | 836 | 11,663,438 |
| N. Atlantic Div. | 1,420 | 78 829 | 3,006 | 5,281,714 | 2,104 | 1,228,041 | 1,625 | 31,403,232 | 410 | 4,424,825 |
| S. Atlantic Div. | 236 | 23,966 | 548 | 1,378,985 | 275 | 242,356 | 119 | 2,000,592 | 45 | 761.008 |
| S. Central Div. | 175 | 6,241 | 484 | 402,584 | 218 | 88,666 | 104 | 973,814 | 43 | 139,240 |
| N. Central Div. | 1,146 | 59,789 | 2,284 | 1,734,813 | 1,501 | 795.894 | 914 | 19,736,027 | 260 | 4,981,564 |
| Western Div. | 271 | 18,055 | 547 | 516,847 | 366 | 208,593 | 226 | 5,074,742 | 78 | 1,356,801 |

## SUMMARY OF STATISTICS OF PUBLIC, SOCIETY, AND SCHOOL LIBRARIES OF 1,000 VOLUMES AND OVER IN 1903.

SOURCES OF SUPPORT.—CLASSIFICATION.

| Division. | Own, Rent, or Buildings Furnished Free. | | | Sources of Support. | | | Free or Subscription. | | | Circulating or Reference. | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Own. | Rent. | Furnished Free. | By Taxation. | By Corporation. | By Donation. | Free. | Free for Reference. | Subscription. | Circulating. | Reference. | Both. |
| United States | 1,376 | 744 | 4,749 | 3,148 | 3,078 | 227 | 2,875 | 2,952 | 1,042 | 477 | 1,485 | 4,907 |
| N. Atlan. Div. | 763 | 300 | 1,863 | 1,221 | 1,336 | 129 | 1,519 | 1,068 | 419 | 264 | 529 | 2,213 |
| S. Atlan. Div. | 82 | 40 | 426 | 164 | 334 | 12 | 89 | 354 | 105 | 29 | 173 | 346 |
| S. Cent. Div. . | 46 | 31 | 407 | 139 | 317 | 14 | 113 | 267 | 104 | 11 | 130 | 343 |
| N. Cent. Div. | 409 | 229 | 1,646 | 1,292 | 871 | 60 | 931 | 1,014 | 339 | 144 | 509 | 1,631 |
| Western Div. | 76 | 64 | 407 | 332 | 190 | 12 | 223 | 249 | 75 | 29 | 144 | 374 |

## SUMMARY OF STATISTICS OF PUBLIC, SOCIETY, AND SCHOOL LIBRARIES OF 1,000 VOLUMES AND OVER IN 1903.

GENERAL CLASSIFICATION OF LIBRARIES.

| Division. | General. | School. | College. | College Society. | Law. | Theological. | Medical. | Government. | State. | Asylum, etc. | Young Men's Christian Association.* | Masonic. | Independent Order of Odd Fellows. | Other Society. | Scientific. | Historical. | Garrison. | Mercantile. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| United States | 2,283 | 2,600 | 642 | 55 | 207 | 156 | 96 | 47 | 65 | 177 | 106 | 19 | 22 | 197 | 89 | 73 | 15 | 20 |
| N. Atlan. Div. | 1,352 | 915 | 121 | 21 | 89 | 67 | 45 | 3 | 15 | 69 | 62 | 3 | 4 | 120 | 51 | 49 | 5 | 15 |
| S. Atlan. Div. | 70 | 201 | 118 | 8 | 23 | 16 | 11 | 37 | 7 | 18 | 9 | 4 | 3 | 11 | 3 | 8 | 1 | .. |
| S. Cent. Div.. | 60 | 225 | 120 | 9 | 10 | 7 | 6 | 1 | 9 | 12 | 9 | 4 | 1 | 8 | 1 | .. | 2 | .. |
| N. Cent. Div.. | 661 | 1,003 | 233 | 17 | 57 | 55 | 28 | 6 | 26 | 70 | 21 | 5 | 9 | 50 | 24 | 13 | 3 | 3 |
| West. Div.... | 140 | 256 | 50 | .. | 28 | 11 | 6 | .. | 8 | 8 | 5 | 3 | 5 | 8 | 10 | 3 | 4 | 2 |

* Including some Y. W. C. A.

## SUMMARY OF STATISTICS OF PUBLIC, SOCIETY, AND SCHOOL LIBRARIES OF 1,000 VOLUMES AND OVER IN 1903.

CLASSIFICATION ACCORDING TO SIZE.

| Division. | Number of Volumes to a Library. | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 500,000 and over. | 300,000 to 499,999. | 100,000 to 299,999. | 50,000 to 99,999. | 25,000 to 49,999. | 10,000 to 24,999. | 5,000 to 9,999. | 1,000 to 4,999. |
| United States.. | 4 | 5 | 50 | 116 | 211 | 649 | 1,024 | 4,810 |
| N. Atlantic Div. | 3 | 4 | 23 | 61 | 112 | 290 | 497 | 2,016 |
| S. Atlantic Div. | 1 | ..... | 7 | 15 | 24 | 67 | 79 | 355 |
| S. Central Div. . | ..... | ..... | 1 | 7 | 6 | 41 | 66 | 363 |
| N. Central Div.. | ..... | 1 | 14 | 28 | 54 | 204 | 310 | 1,673 |
| Western Div.... | ..... | ..... | 5 | 5 | 15 | 47 | 72 | 403 |

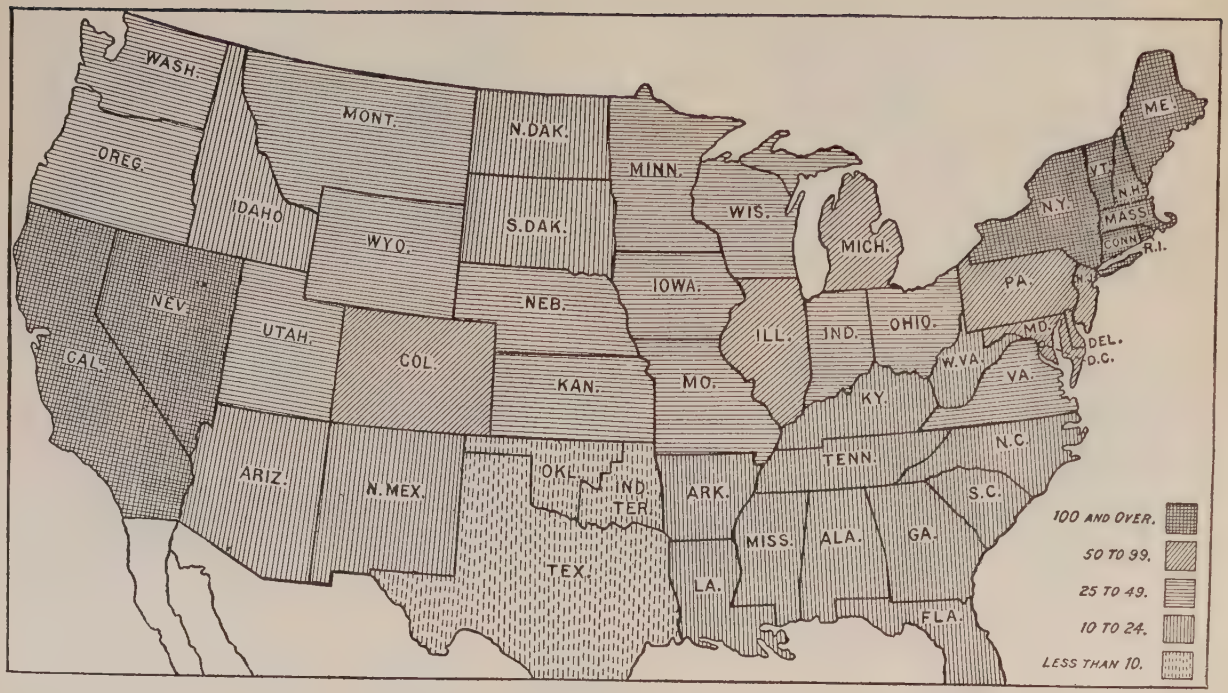


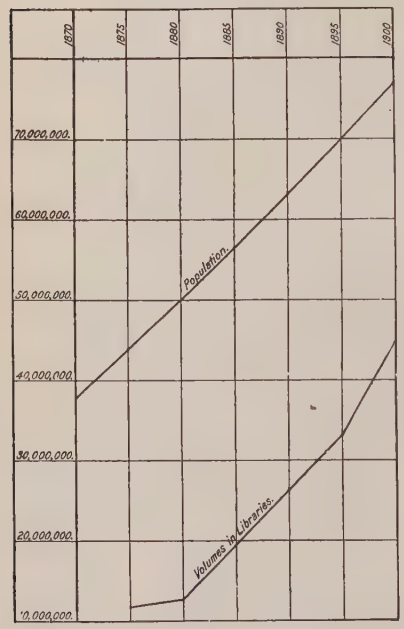

CHART SHOWING RELATIVE NUMBER OF VOLUMES TO EACH 100 POPULATION IN 1900.

## SUMMARY OF STATISTICS OF PUBLIC, SOCIETY, AND SCHOOL LIBRARIES OF 1,000 VOLUMES AND OVER IN 1903.

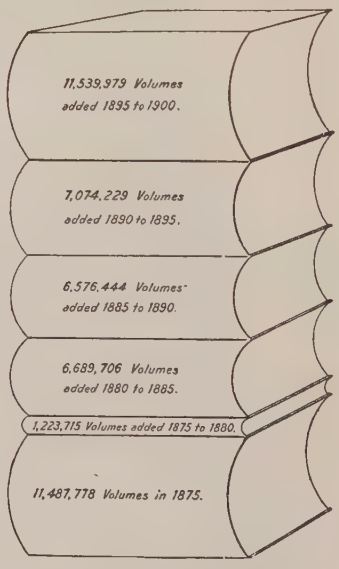
DISTRIBUTION OF LIBRARIES AND VOLUMES.

| Division. | Libraries. | Volumes. | Census Estimate of Population 1903. | Number People per Library. | Number Books per 100 People. |
|---|---|---|---|---|---|
| United States..... | 6,869 | 54,419,002 | 79,900,389 | 11,632 | 68 |
| North Atlantic Div .. | 3,006 | 27,805,980 | 22,140,788 | 7,366 | 126 |
| South Atlantic Div .. | 548 | 6,025,022 | 10,931,970 | 19,949 | 55 |
| South Central Div ... | 484 | 2,524,283 | 14,941,636 | 30,871 | 17 |
| North Central Div... | 2,284 | 14,542,460 | 27,490,996 | 12,036 | 53 |
| Western Division.... | 547 | 3,521,257 | 4,394,999 | 8,035 | 80 |

—*From Reports of the Bureau of Education.*




THE RELATION OF LIBRARIES TO POPULATION.

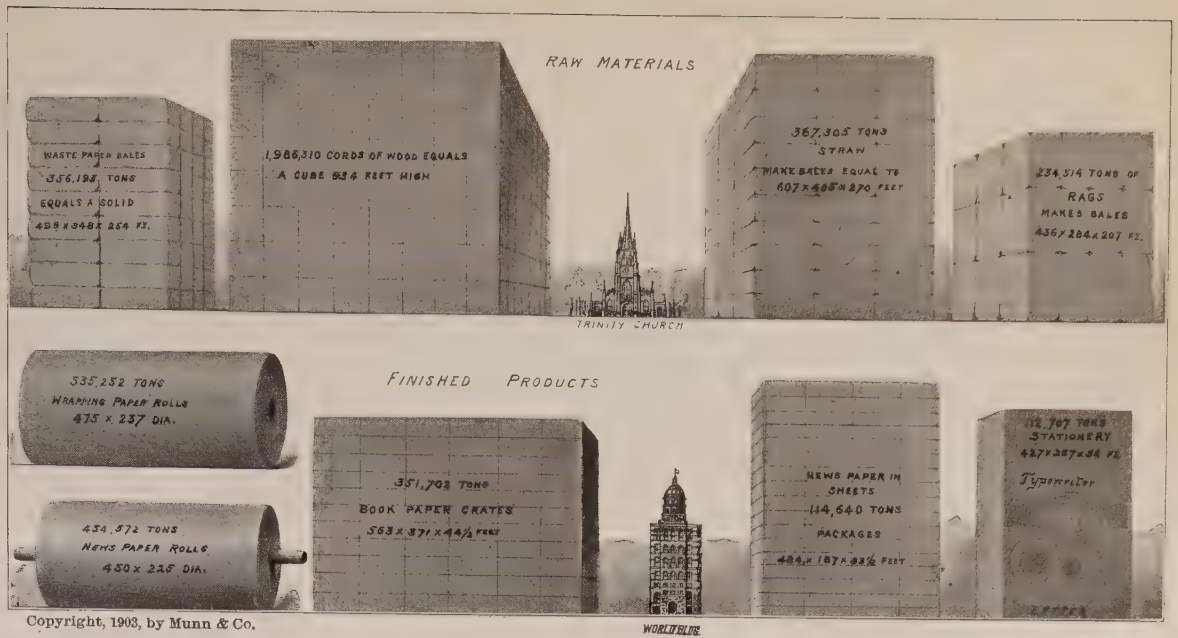



IN 5,383 LIBRARIES THESE WERE IN 1900, 44,591,851 VOLUMES.

## PRINTING AND PUBLISHING.

There were 18,226 publications reported to the census authorities, while 3,046 publications failed to report. This would give a remarkable total of 21,272 periodicals, and the aggregate circulation of those reporting was 114,299,334 per issue, while the aggregate number of copies issued during the census year was 8,168,148,749.

The average capital of those engaged in the printing business is $12,574; the average value of their products is $14,569. These figures compared with those of a previous decade show that in a period of ten years an increased capital is required to produce the same or even a smaller value of products; this is largely caused by an

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A GRAPHICAL COMPARISON OF RAW AND FINISHED PRODUCTS CONSUMED ANNUALLY IN THE MANUFACTURE OF BOOKS AND PERIODICALS IN THE UNITED STATES.

When figures get beyond a certain point they lose their concrete value, and it is necessary to resort to some other means if we wish to make comparisons involving figures that run up into millions and billions. Therefore, we adopt the method of representing these figures by comparisons of bulk and form. The basis for the comparison which we have worked out is the Twelfth Census of the United States, viz: that of 1900.

increase in wages and a decrease in working hours. In 1850 a compositor in New York received $9 per week; ordinary job compositors now receive $19.50 per week, and operators on machines from $24 to $27, depending on the time of day or night they take their shift. In the opinion of many large operators, the number of wage earners has actually increased rather than diminished. The introduction of machine composition has been of decided benefit to the employee, offering a new field for endeavor. There are few unemployed men in the printing trade, as is shown by the fact that when in 1900 the Typographical Union was called upon to supply 150 men for a special job of city printing, only 100 could be obtained, and these with difficulty.

A classified list of periodicals is given below, showing how the list is divided:

| Period of issue: | |
|---|---|
| Daily | 2,226 |
| Tri-weekly | 62 |
| Semi-weekly | 637 |
| Weekly | 12,979 |
| Monthly | 1,817 |
| Quarterly | 237 |
| All other classes | 268 |
| Total | 18,226 |

| Character of publication: | |
|---|---|
| News, politics, and family reading | 14,867 |
| Religion | 952 |
| Agriculture, horticulture, dairying, and stock-raising | 307 |
| Commerce, finance, insurance, railroads, and trade | 710 |
| General literature, including magazines | 239 |
| Medicine and surgery | 111 |
| Law | 62 |
| Science and mechanics | 66 |
| Fraternal organizations | 200 |
| Education and history | 259 |
| Society, art, music and fashion | 88 |
| Miscellaneous | 365 |

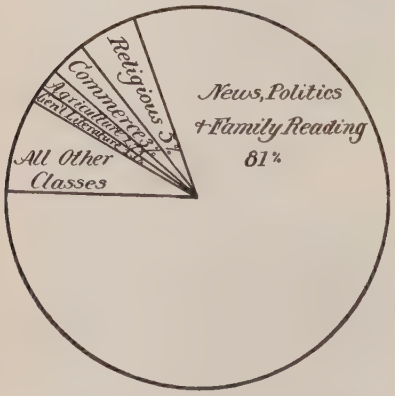
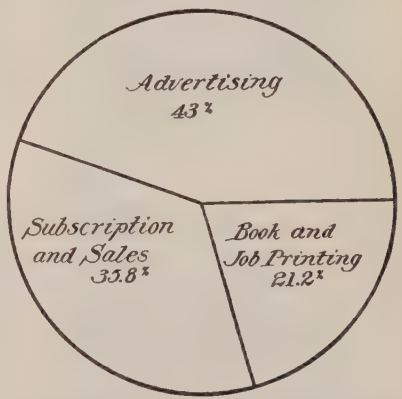
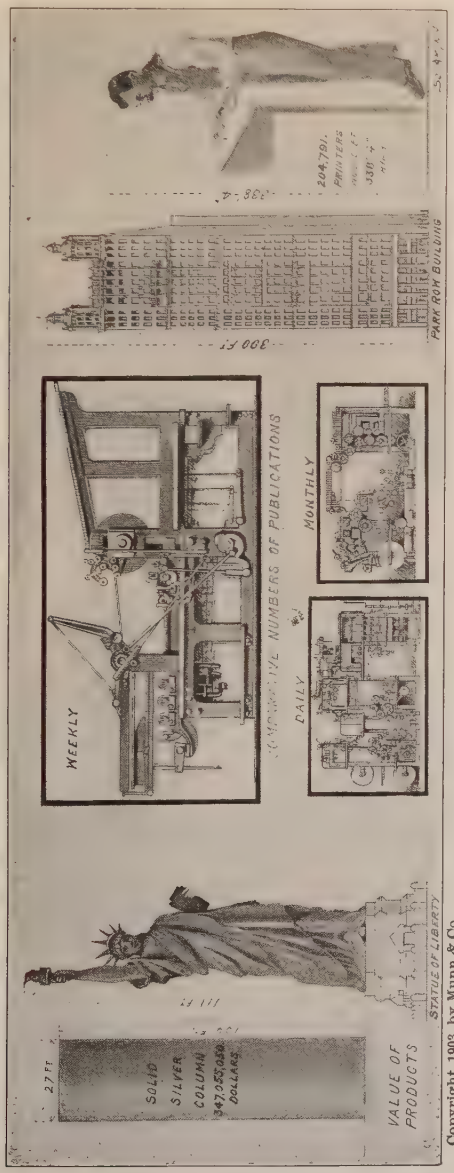



DIAGRAM SHOWING CLASSIFICATION OF PAPERS.




PROPORTION WHICH ADVERTISING, SUBSCRIPTION AND SALES, AND BOOK AND JOB PRINTING FORM OF THE TOTAL VALUE OF ALL PRODUCTS.

Out of the 18,226 publications, 2,226 are dailies, with a circulation of 15,102,156; 62 are tri-weekly, with a circulation of 228,610; 637 are semi-weekly, with a circulation of 2,832,868; 12,979 papers are issued weekly, with a circulation of 39,852,052. There are 1,817 monthly publications, whose circulation is 39,519,897. The quarterly publications are mostly devoted to special subjects, and only number 237, but their circulation is very respectable, as they issue 11,217,422 per number. Semi-monthly, semi-annual and yearly publications number 268, and have a circulation of 5,546,329. Out of 18,226 publications, 17,194 were printed in English.

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COMPARISON SHOWING NUMBER OF PUBLICATIONS, VALUE OF PRODUCT AND LABOR.

In 1900, cities of 20,000 inhabitants and over contained 79 per cent of the separate job-printing establishments of the country, and 97.7 per cent of the total job product emanated from them.

Ayer's Newspaper Directory for 1904 gives later figures, viz.: Daily, 2,457; tri-weekly, 56; semi-weekly, 634; weekly, 16,935; fortnightly, 65; semi-monthly, 285; monthly, 2,698; bimonthly, 53; quarterly, 192; miscellaneous, 10. Total, 23,385.

## QUANTITY AND COST OF PAPER USED.

| Kinds. | Pounds | Cost. | Average cost per pound. cents. |
|---|---|---|---|
| News | 956,335,921 | $22,197,0. 0 | 2.3 |
| Book and periodical | 202,296,263 | 9,356,490 | 4.6 |
| Job printing | 74,510,064 | 6,270,306 | 8.4 |
| Total | 1,233,142,248 | $37,823,856 | 3.1 |

Our figures show the quantity and cost of paper used and the average cost per pound in 1900.

In this table is presented a division of the paper used in 1900, according to the several classes of products which, combined, produced the total value of products of newspaper and periodical establishments. About one and a quarter billions of pounds was used during the year in which the census was undertaken. This large quantity was utilized in the following proportions:

| | Per cent. |
|---|---|
| News | 77.6 |
| Book and periodical | 16.4 |
| Job printing | 6.0 |

## LIBRARIES OF THE WORLD.

The following is a list of the principal Libraries of the world:

| Library. | City. | No. of Vols. |
|---|---|---|
| Bibliothèque nationale | Paris | 2,602,000 |
| British Museum | London | 2,003,000 |
| Imper. publicnaja biblioteka | St. Petersburg | 1,329,000 |
| Königliche bibliothek | Berlin | 1,200,000 |
| Library of Congress | Washington | 1,000,000 |
| Kön. Hof- u. Staatsbibliothek | Munich | 1,000,000 |
| K. u. k. Hofbibliothek | Vienna | 900,000 |
| Universitäts- u. landesbibliothek | Strasburg | 814,000 |
| Public Library | Boston | 812,260 |
| Publicnyj i Rumjancovskij musej | Moscow | 800,000 |
| Public Library—Astor, Lenox, and Tilden Foundation | New York City | 787,700 |
| Biblioteca nacional | Madrid | 600,000 |
| Bodleian Library | Oxford | 600,000 |
| K. k. Universitäts-bibliothek | Vienna | 596,526 |
| Harvard University Library | Cambridge (U. S.) | 575,889 |
| Cambridge University Library | Cambridge (Eng.) | 550,000 |
| Det store kongelige bibliothek | Copenhagen | 550,000 |
| Universitäts-bibliothek | Göttingen | 506,814 |
| Universiteit bibliotheek | Amsterdam | 500,000 |
| Kön. bibliotheek | The Hague | 500,000 |

## THE RAPID EXTENSION IN THE GATHERING OF NEWS.

In 1886 the New York World reported the battle of Majuba Hill in six lines, but so rapid was the extension of news gathering that, fourteen years later, events in the same quarter of the globe were reported to the great American dailies by cable as fully as though close at hand. The destruction of St. Pierre, Martinique, in 1902, by an eruption of Mont Pelée, may be mentioned as an illustration of this tendency.

The cablegrams which detailed that great disaster reached American newspapers by way of Brazil, the Azores and Great Britain, costing the recipients from $2 to $4 per word, with fees for precedence.

# CHAPTER VIII.

## TELEGRAPHS, TELEPHONES, SUBMARINE CABLES, WIRELESS TELEGRAPHY, AND SIGNALING.

### LAND LINES OF THE WORLD.

Below are given such particulars as we have been able to obtain of the land lines of telegraphs throughout the world, corrected up to December 31, 1903:

| Countries. | Length of Lines in Miles. | | | Length of Conductors in Miles. | | | Pneumatic Tubes (Yds.). |
|---|---|---|---|---|---|---|---|
| | Aerial. | Underground. | Total. | Aerial. | Underground. | Total. | |
| African Transcont'ntal Tel. Co. | 1,595 | ..... | 1,595 | 1,595 | ..... | 1,595 | ..... |
| Austria | 21,523 | 104 | 21,627 | 69,404 | 1,579 | 70,983 | 83,406 |
| Bahamas | 6 | ..... | 6 | ..... | ..... | ..... | ..... |
| Belgium | 4,041 | 9 | 4,050 | 21,318 | 253 | 21,571 | 3,352 |
| Bolivia | 1,795 | ..... | 1,795 | ..... | ..... | ..... | ..... |
| Bosnia-Herzegovina | 1,762 | ..... | 1,762 | 3,807 | ..... | 3,807 | ..... |
| Brazil | 14,677 | ..... | 14,677 | 27,670 | ..... | 27,670 | ..... |
| British East Africa | 120 | ..... | 120 | 126 | ..... | 126 | ..... |
| British Guiana | 312 | ..... | 312 | 1,234 | ..... | 1,234 | ..... |
| British India (India Office) | 55,055 | ..... | 55,055 | 181,883 | ..... | 181,883 | ..... |
| British North Borneo | 599 | ..... | 599 | ..... | ..... | ..... | ..... |
| British South Africa | 4,765 | ..... | 4,765 | 4,765 | ..... | 4,765 | ..... |
| Bulgaria | 3,263 | 1 | 3,264 | 6,835 | ..... | 6,835 | ..... |
| Canada—Gt. N.-West. Tel. Co. | 18,286 | ..... | 18,286 | 34,794 | ..... | 34,794 | ..... |
| Canadian Pacific Telegraphs | 9,900 | 2 | 9,902 | 44,685 | 57 | 44,742 | ..... |
| Western Union Tel. Co. | 2,756 | 28 | 2,784 | 13,025 | 44 | 13,069 | ..... |
| Government Tel. Service | 5,481 | ..... | 5,481 | 5,481 | ..... | 5,481 | ..... |
| Cape Colony | 8,018 | 11 | 8,029 | 28,763 | 2,190 | 30,953 | ..... |
| Ceylon | 1,519 | ..... | 1,519 | 2,721 | ..... | 2,721 | ..... |
| Chile | 7,473 | ..... | 7,473 | 13,344 | ..... | 13,344 | ..... |
| China | 14,000 | ..... | 14,000 | ..... | ..... | ..... | ..... |
| Corea | 1,200 | ..... | 1,200 | 1,350 | ..... | 1,350 | ..... |
| Costa Rica | 835 | ..... | 835 | ..... | ..... | ..... | ..... |
| Denmark | 3,811 | 7 | 3,818 | 12,538 | 472 | 13,010 | ..... |
| Dutch Indies | 5,459 | 15 | 5,474 | 8,070 | 41 | 8,111 | ..... |
| Ecuador | 2,070 | ..... | 2,070 | ..... | ..... | ..... | ..... |
| Egypt | 2,538 | ..... | 2,538 | 10,755 | ..... | 10,755 | ..... |
| France, Continent and Corsica | 55,157 | 3,997 | 59,154 | 196,657 | 13,858 | 210,515 | 288,828 |
| " Algeria | 4,445 | 16 | 4,461 | 10,417 | 166 | 10,583 | ..... |
| French Guiana (Cayenne) | 171 | ..... | 171 | 171 | ..... | 171 | ..... |
| French Indo-China (Cochin-China, Cambodia, Annam, Tonkin, and Laos) | 7,587 | 39 | 7,626 | 13,422 | 68 | 13,490 | ..... |
| Germany | 77,828 | 3,953 | 81,781 | 276,684 | 27,116 | 303,800 | 180,204 |
| Great Britain and Ireland | 43,023 | 1,768 | 44,791 | 305,366 | 104,012 | 409,378 | 114,400 |
| Greece | 5,717 | 1 | 5,718 | 8,590 | 1 | 8,591 | ..... |
| Holland | 3,779 | 229 | 4,008 | 15,397 | 761 | 16,158 | 1,004 |
| Hungary | 23,036 | 33 | 23,069 | 117,154 | 2,498 | 119,652 | ..... |
| Indo-European Persian Gulf System (Mekran Coast) | 698 | ..... | 698 | 1,392 | ..... | 1,392 | ..... |
| Indo-European Teheran, Bushire Line | 693 | ..... | 693 | 2,079 | ..... | 2,079 | ..... |
| Italy | 24,370 | ..... | 24,370 | 94,225 | ..... | 94,225 | ..... |
| [1] Japan | 16,374 | 7 | 16,381 | 78,264 | 680 | 78,944 | ..... |

[1] Exclusive of 20.148 nautical miles of river cables and 39.031 miles of conductors.

LAND LINES OF THE WORLD—*Continued.*

| Countries. | Length of Lines in Miles. | | | Length of Conductors in Miles. | | | Pneumatic Tubes (Yds.). |
|---|---|---|---|---|---|---|---|
| | Aerial. | Underground. | Total. | Aerial. | Underground. | Total. | |
| Luxemburg | 259 | ..... | 259 | 508 | ..... | 508 | ..... |
| Malay States (Federated) | 969 | ..... | 969 | 460 | ..... | 1,429 | ..... |
| Mauritius | 141 | ..... | 141 | 316 | ..... | 316 | ..... |
| [1] Mexico | 20,258 | ..... | 20,258 | 31,454 | ..... | 31,454 | ..... |
| Natal | 1,722 | ..... | 1,722 | 4,678 | ..... | 4,678 | ..... |
| Netherlands East India | 12,441 | ..... | 12,441 | ..... | ..... | ..... | ..... |
| New South Wales | 14,430 | 95 | 14,525 | 53,671 | 4,946 | 58,617 | ..... |
| New Zealand | 7,749 | ..... | 7,749 | 22,672 | ..... | 22,672 | ..... |
| Nicaragua | 1,694 | ..... | 1,694 | 2,326 | ..... | 2,326 | ..... |
| North American Tel. Co. | 1,074 | ..... | 1,074 | 2,306 | ..... | 2,306 | ..... |
| Norway | 5,479 | ..... | 5,479 | 11,402 | ..... | 11,402 | 44 |
| [2] Peru | 2,716 | ..... | 2,716 | 2,820 | ..... | 2,820 | ..... |
| Portugal | 5,298 | ..... | 5,298 | 11,669 | ..... | 11,669 | ..... |
| Queensland | 10,269 | ..... | 10,269 | 20,806 | ..... | 20,806 | ..... |
| Roumania | 3,439 | 9 | 3,448 | 7,388 | 41 | 7,429 | ..... |
| Russia | 76,484 | 192 | 76,676 | 177,148 | 427 | 177,575 | ..... |
| Senegal | 1,501 | 11 | 1,512 | 2,038 | 11 | 2,049 | ..... |
| Servia | 1,689 | ..... | 1,689 | 3,803 | ..... | 3,803 | ..... |
| South Australia | 5,783 | ..... | 5,783 | 18,467 | ..... | 18,467 | ..... |
| Southern Rhodesia | 2,233 | ..... | 2,233 | 4,496 | ..... | 4,496 | ..... |
| Spain | 24,481 | 366 | 24,847 | 48,749 | 323 | 49,072 | ..... |
| Sudan Provinces | 3,052 | ..... | 3,052 | 3,451 | ..... | 3,451 | ..... |
| Sweden | 5,699 | 5 | 5,704 | 17,609 | 60 | 17,669 | ..... |
| Switzerland | 3,907 | 58 | 3,965 | 12,912 | 1,745 | 14,657 | ..... |
| Tasmania | 1,778 | ..... | 1,778 | 2,803 | 6 | 2,809 | ..... |
| Tunis | 1,398 | 5 | 1,403 | 2,537 | 5 | 2,542 | ..... |
| Turkey | 24,831 | ..... | 24,831 | 39,519 | ..... | 39,519 | ..... |
| Uganda Protectorate | 246 | ..... | 246 | 246 | ..... | 246 | ..... |
| " State Rly. Telegraphs | 950 | ..... | 590 | 1,762 | ..... | 1,762 | ..... |
| United States of America: | | | | | | | |
| Commercial Cable Co. | 27,344 | 153 | 27,497 | 192,566 | 7,829 | 200,395 | 4,900 |
| [3] Western Union Company | 184,636 | 252 | 184,888 | 1,050,186 | 15,211 | 1,065,397 | ..... |
| Victoria—Postal Department | 4,001 | 1 | 4,002 | 9,894 | 38 | 9,932 | 3,697 |
| " Rly. Department | 2,588 | ..... | 2,588 | 3,795 | ..... | 3,795 | ..... |
| Western Australia | 6,066 | ..... | 6,066 | 9,118 | ..... | 9,118 | ..... |
| Total | 922,342 | 11,367 | 933,709 | 3,387,716 | 184,438 | 3,572,154 | 679,835 |

[1] Inclusive of 535 miles of lines and 569 miles of conductors belonging to the Peruvian Corporation.

[2] Exclusive of 811 miles of miscellaneous subaqueous cables and 2,320 miles of conductors.

[3] Exclusive of 404.6 nautical miles of cable in Gulf of Mexico.

—*Electrical Trades Directory.*

## MILEAGE OF LINES AND WIRES, NUMBER OF OFFICES, AND TRAFFIC OF THE WESTERN UNION TELEGRAPH COMPANY.

| Year Ending June 30— | Miles of Line. | Miles of Wire. | Number of Offices. | Number of Messages Sent. | Receipts. | Expenses. | Profits. | Average per Message. | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Toll. | Cost. |
| | | | | | Dollars. | Dollars. | Dollars. | Cents. | Cents. |
| 1868 | 50,183 | 97,594 | 3,219 | 6,404,595 | 7,004,560 | 4,362,849 | 2,641,711 | 104.7 | 63.4 |
| 1878 | 81,002 | 206,202 | 8,014 | 23,918,894 | 9,861,355 | 6,309,813 | 3,551,543 | 38.9 | 25.0 |
| 1888 | 171,375 | 616,248 | 17,241 | 51,463,955 | 19 711,164 | 14,640,592 | 5,070,572 | 31.2 | 23.2 |
| 1898 | 189,847 | 874,420 | 22,210 | 62,173,749 | 23,915,733 | 17,825,582 | 6,090,151 | 30.1 | 24.7 |
| 1904 | 199,350 | 1,155,405 | 23,458 | *67,903,973 | 29,249,390 | 21,361,915 | 7,887,475 | 31.7 | 26.1 |

* Not including messages sent over leased wires or under railroad contracts.

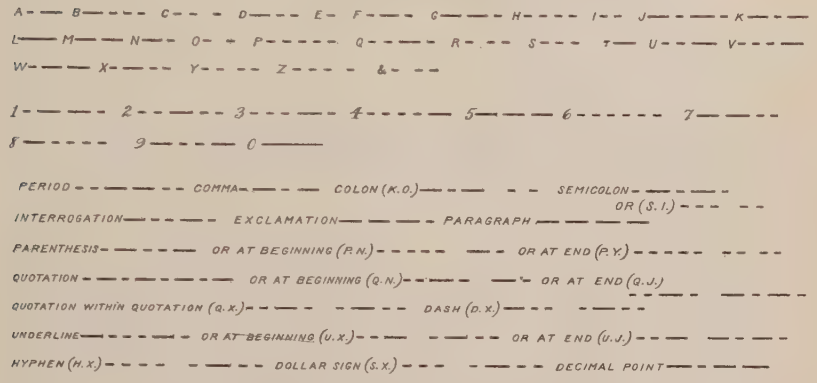
The greatly increased mileage since 1880 is principally due to the fact that in 1881 the Western Union Telegraph Company absorbed by purchase all the lines of the American Union and the Atlantic and Pacific Telegraph Companies, the former having previously in operation over 12,000 miles of line and the latter 8,706 miles. Capital stock of the Western Union, $100,000,000.

The Western Union has exclusive contracts with several international cable companies, operating eight Atlantic cables, and guarantees 5 per cent annual dividends on the stock of the American Telegraph and Cable Company; amount $14,000,000.

Besides the above, there are new lines of telegraph which have complied with the United States telegraph act of 1866, and are operating wires with or without connection with railway companies in many parts of the country.—*Statistical Abstract of the United States.*

## THE MORSE TELEGRAPH CODE.

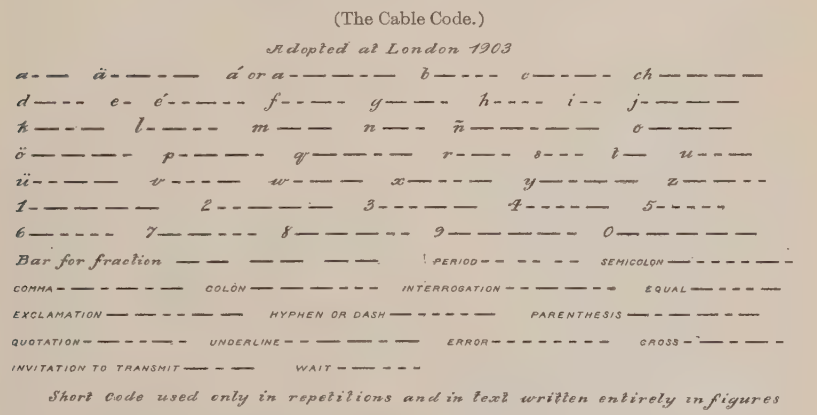
(Used in the United States.)


A B C D E F G H I J K
L M N O P Q R S T U V
W X Y Z & 1 2 3 4 5 6 7 8 9 0
PERIOD COMMA COLON (K.O.) SEMICOLON OR (S.I.)
INTERROGATION EXCLAMATION PARAGRAPH
PARENTHESIS OR AT BEGINNING (P.N.) OR AT END (P.Y.)
QUOTATION OR AT BEGINNING (Q.N.) OR AT END (Q.J.)
QUOTATION WITHIN QUOTATION (Q.X.) DASH (D.X.)
UNDERLINE OR AT BEGINNING (U.X.) OR AT END (U.J.)
HYPHEN (H.X.) DOLLAR SIGN (S.X.) DECIMAL POINT

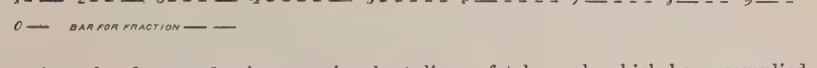
## THE INTERNATIONAL TELEGRAPH CODE.

(The Cable Code.)

*Adopted at London 1903*


a ä á or a b c ch
d e é f g h i j
k l m n ñ o
ö p q r s t u
ü v w x y z
1 2 3 4 5
6 7 8 9 0
Bar for fraction
PERIOD SEMICOLON
COMMA COLON INTERROGATION EQUAL
EXCLAMATION HYPHEN OR DASH PARENTHESIS
QUOTATION UNDERLINE ERROR CROSS
INVITATION TO TRANSMIT WAIT

*Short Code used only in repetitions and in text written entirely in figures*



## MILEAGE OF LINES AND WIRES, NUMBER OF OFFICES, AND MESSAGES SENT, OF THE POSTAL TELEGRAPH CABLE COMPANY.

| Year. | Miles of Poles and Cable Operated but not Owned. | Miles of Poles and Cable Owned. | Miles of Wires. | Offices. | Messages. |
|---|---|---|---|---|---|
| 1885 | ..... | 2,811 | 23,587 | 260 | 1,428,690 |
| 1897 | 16,011 | 21,098 | 178,438 | 9,875 | 13,628,064 |
| 1903 | 21,319 | 27,482 | 276,245 | 19,977 | 21,600,577 |

The aggregate mileage of telegraph lines which carry varying numbers of wires, according to the business requirements of the localities through which they run, in the United States open for public business exceeds 210,000 miles, besides railways, Government, private and telephonic lines; the length of the latter not being ascertainable.

## STATISTICS OF THE AMERICAN TELEPHONE AND TELEGRAPH COMPANY AND OPERATING COMPANIES ASSOCIATED WITH IT ON JANUARY 1, FROM 1897 TO 1904.

| Data. | 1897. | 1900. | 1904. |
|---|---|---|---|
| Exchanges | 967 | 1,239 | 1,609 |
| Branch offices | 832 | 1,187 | 2,131 |
| Miles of wire: | | | |
| On poles | 286,632 | 509,036 | [1] 1,358,140 |
| On buildings | 12,594 | 15,087 | |
| Underground | 234,801 | 489,250 | 1,618,691 |
| Submarine | 2,818 | 3,404 | 6,358 |
| Total miles of exchange service wire | 536,845 | 1,016,777 | 2,983,189 |
| Total circuits | 264,645 | 422,620 | 798,901 |
| Total employees | 14,425 | 25,741 | 53,795 |
| Total subscribers | 325,244 | 632,946 | 1,525,167 |
| Length of wire operated.....miles.. | 805,711 | 1,518,609 | 3,958,891 |
| Instruments in hands of licensees under rental at beginning of year.....No... | 772,627 | 1,580,101 | 3,779,517 |
| Daily exchange connections..... " .. | 2,630.071 | 5,173,803 | 9,876,402 |
| Average daily calls per subscriber... ..... " .. | 8.3 | 8.2 | 6.5 |
| Received in rentals of telephones.....dollars.. | 1,597,959 | 2,427,038 | 8,619,151 |
| Dividends paid stockholders..... " .. | 3,682,949 | 4,078,601 | 156,151,680 |
| Capital..... " .. | ..... | 89,100,500 | 16,545,632 |
| Gross earnings..... " .. | 5,130,845 | 9,534,499 | 10,564,665 |
| Net earnings..... " .. | 4,169,675 | 5,486,058 | ..... |

[1] Information is for 1903.

## TELEGRAPHIC TIME SIGNALS SENT OUT AT NOON DAILY, EXCEPT SUNDAYS AND HOLIDAYS, BY THE U. S. NAVAL OBSERVATORY.

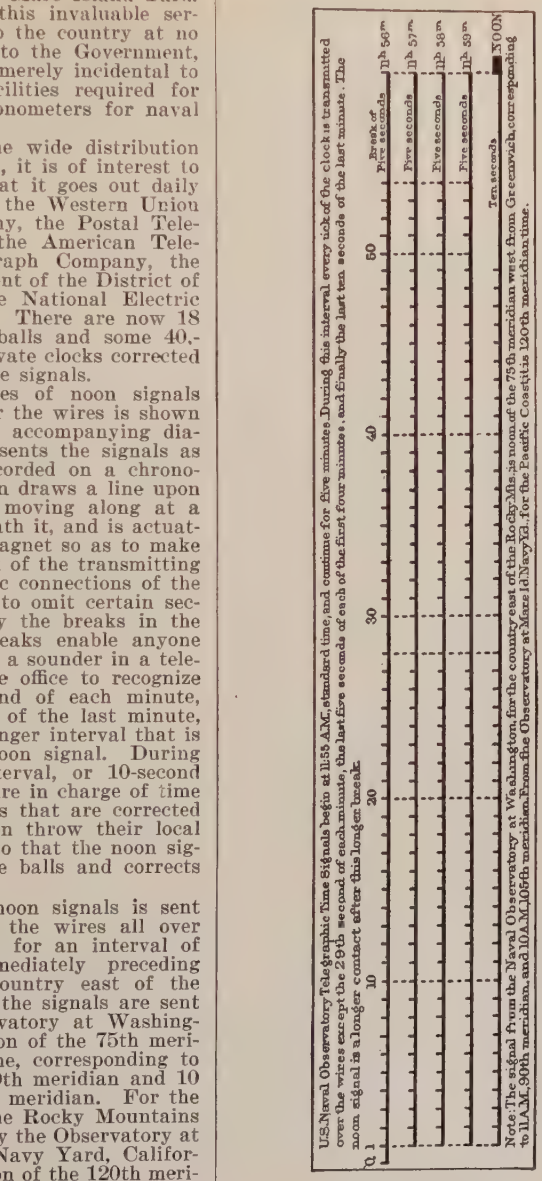
The time service of the U. S. Naval Observatory has continued regularly to send out daily telegraphic time signals at noon, seventy-fifth meridian time, with an average error for the year of only 0s 15. The widespread importance of this service is shown by the fact that it furnishes absolute standard time not only for navigators at all the principal seaports, but for the entire country except the Pacific Coast, which gets a similar signal from the Naval

Observatory at the Mare Island Yard. Moreover, all of this invaluable service is rendered to the country at no expense whatever to the Government, inasmuch as it is merely incidental to the work and facilities required for the rating of chronometers for naval vessels.

To illustrate the wide distribution of this time signal, it is of interest to record the fact that it goes out daily over the wires of the Western Union Telegraph Company, the Postal Telegraph Company, the American Telephone and Telegraph Company, the electrical department of the District of Columbia, and the National Electric Supply Company. There are now 18 Government time-balls and some 40,000 public and private clocks corrected daily by naval time signals.

The entire series of noon signals sent out daily over the wires is shown graphically in the accompanying diagram. This represents the signals as they would be recorded on a chronograph, where a pen draws a line upon a sheet of paper moving along at a uniform rate beneath it, and is actuated by an electro-magnet so as to make a jog at every tick of the transmitting clock. The electric connections of the clock are such as to omit certain seconds, as shown by the breaks in the record. These breaks enable anyone who is listening to a sounder in a telegraph or telephone office to recognize the middle and end of each minute, especially the end of the last minute, when there is a longer interval that is followed by the noon signal. During this last long interval, or 10-second break, those who are in charge of time balls and of clocks that are corrected electrically at noon throw their local lines into circuit so that the noon signal drops the time balls and corrects the clocks.

This series of noon signals is sent continuously over the wires all over the United States for an interval of five minutes immediately preceding noon. For the country east of the Rocky Mountains the signals are sent out by the Observatory at Washington and end at noon of the 75th meridian, standard time, corresponding to 11 a. m. of the 90th meridian and 10 a. m. of the 105th meridian. For the country west of the Rocky Mountains they are sent out by the Observatory at the Mare Island Navy Yard, California, and end at noon of the 120th meridian, the standard time meridian of the Pacific Coast. The transmitting clock


U.S.Naval Observatory Telegraphic Time Signals begin at 11h55 A.M. standard time, and continue for five minutes. During this interval every tick of the clock is transmitted over the wires except the 29th second of each minute, the last five seconds of each of the first four minutes, and finally the last ten seconds of the last minute. The noon signal is a longer contact after this longer break.
0
1
10
20
30
40
50
60
Break of Five seconds
11h 56m
Five seconds
11h 57m
Five seconds
11h 58m
Five seconds
11h 59m
Ten seconds
NOON
Note. The signal From the Naval Observatory at Washington, for the country east of the Rocky Mts., is noon of the 75th meridian west from Greenwich, corresponding to 11 A.M. 90th meridian, and 10 A.M. 105th meridian. From the Observatory at Mare Island Navy Yd. for the Pacific Coast it is 120th meridian time.

TELEGRAPHIC TIME SIGNALS AS SENT OUT BY THE U. S. NAVAL OBSERVATORY.

that sends out the signals is corrected very accurately, shortly before noon, from the mean of three standard clocks that are rated by star sights with a meridian transit instrument. The noon signal is seldom in error to an amount greater than one or two tenths of a second, although a tenth more may be added by the relays in use on long telegraph lines. Electric transmission over a continuous wire is practically instantaneous. For time signals at other times than noon, similar signals can be sent out by telegraph or telephone from the same clock that sends out the noon signal.

## STANDARD TIME

The desirability of using a uniform standard of time, independent of local time, was recognized at a very early date. The differences of local time arise from the use of solar motion as a time-measurer. We call the time noon when the sun is opposite the meridian of the place where we are living, and in consequence of the sun's motion from east to west, the more easterly of two places will have the earlier time, the difference in hours being exactly 1-15th of the longitudinal difference in degrees. In other words, 15 degrees of longitude correspond to a time difference of one hour. Peculiar difficulties were encountered in this country on account of its vast longitudinal extent, and the inconvenience became very serious with the extension of the railroad and telegraph systems.

The movement which resulted in the adoption of the present time system may be said to have originated in a report on the subject by the American Meteorological Society, which was submitted at a meeting of the General Time Convention held on Oct. 13, 1881, proposing a single standard for the whole country and suggesting the hour theory as an alternative proposition. The matter was referred to the secretary, Mr. W. T. Allen, and communications were invited from parties interested. The proposal to fix one standard of time for the whole country was supported by many competent authorities; but, although there was much to recommend it from a scientific point of view, it was found to be impracticable on account of the many discrepancies which would occur between time by the clock and solar time. The system which found most favor, and was finally adopted, proposed the division of the country into four time sections, each of 15 degrees longitude (7½ degrees or 30 minutes on each side of the meridian), commencing with the 75th meridian. Inside each of these sections time was to be uniform, the time of each section differing from that next to it by exactly one hour. A scheme was drawn up in accordance with these principles, and at a meeting of the convention held in April, 1883, the following resolutions were adopted:

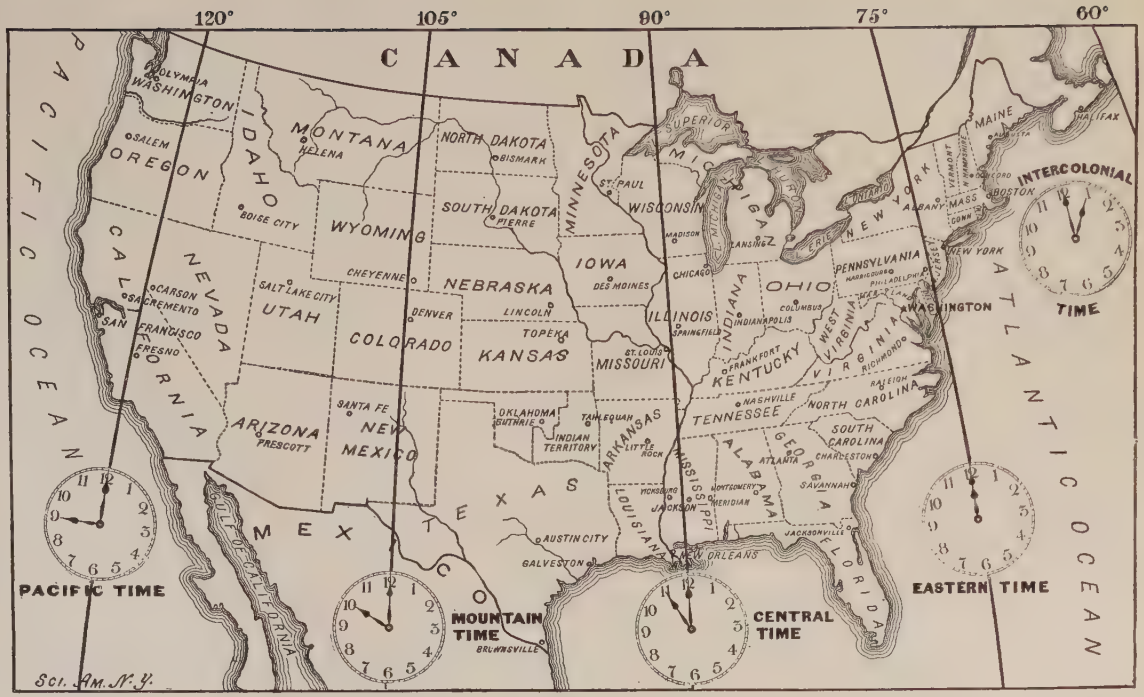
(1.) That all roads now using Boston, New York, Philadelphia, Baltimore, Toronto, Hamilton, or Washington time as standard, based upon meridians east of those points or adjacent thereto, shall be governed by the 75th meridian or Eastern time (4 minutes slower than New York time.)

(2.) That all roads now using Columbus, Savannah, Atlanta, Cincinnati, Louisville, Indianapolis, Chicago, Jefferson City, St. Paul, or Kansas City time, or standards based upon meridians adjacent thereto, shall be run by the 90th meridian time, to be called Central time, one hour slower than Eastern time and 9 minutes slower than Chicago time.

(3.) That west of the above-named sections the roads shall be run by the 105th and the 120th meridian times respectively, two and three hours slower than Eastern time.

(4.) That all changes from one hour standard to another shall be made at the termini of roads or at the ends of divisions.

The advantages of this method of reckoning time are obvious. Every town, instead of regulating its business by its own local time, uses the time of the nearest of the standard meridians, and the difference in time in actual use in any two cities will be an exact number of hours, instead of a number of hours, minutes and seconds. A traveler, therefore, wishing to reset his watch, need only change the hour, without paying any attention to the minutes. Having proceeded, *e. g.*, from New York to any town within the Central time zone, he has simply to set his watch one hour slow of New York time, and need not compare it with any of the local clocks.




STANDARD TIME IN THE UNITED STATES,

## VARIATION OF TIME IN DIFFERENT COUNTRIES.

NOTE.—Hours of the night, **6** p.m. to **5.59** a.m., are in dark type.

Trains in Great Britain, Belgium, Holland, and Spain run on Greenwich (West Europe) time; in Switzerland, Italy, Denmark, Sweden, Germany, Austria, and Servia, on Mid-European time (one hour fast of Greenwich); in France at 5 minutes behind Paris time (see below); and in Roumania, Bulgaria, and part of Turkey, on East European time (two hours faster than Greenwich).

Outside clocks at French stations show Paris time, but inside clocks—by which trains are worked—are 5 minutes slower than outside. Thus there is only 4 minutes 20.6 seconds difference between English and French railway time.—*Cook's Continental Time Tables.*

| WHEN IT IS 12 NOON AT | Mean Time of | IT IS THE FOLLOWING TIME AT | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Amsterdam (local time). | Athens. | Berlin (local time). | Berne (local time). | Brussels (local time). | Budapest (local time). | Cairo. | Christiania. | Cologne (local time). | Copenhagen (local time). | East European Time. | Greenwich. | Jerusalem. | Melbourne. | Mid-European Time. | Munich (local time). | New York. | Ottawa. | Paris. | Rome (local time). | St. Petersburg. | Stockholm (local time). | Sydney. | Vienna (local time). | | | | | |
| | | no'n | p.m. | p.m. | p.m. | a.m. | p.m. | p.m. | p.m. | p.m. | p.m. | p.m. | a.m. | p.m. | p.m. | p.m. | p.m. | a.m. | a.m. | a.m. | a.m. | p.m. | p.m. | a.m. | p.m. | | | | | |
| Amsterdam. | ..... | 12 0 | 1 15 | 12 34 | 12 10 | 11 35 | 12 57 | 1 40 | 12 30 | 12 8 | 12 31 | 1 40 | 11 40 | 2 1 | **9 20** | 12 40 | 12 27 | 6 44 | 6 40 | 11 50 | 12 30 | 1 42 | 12 53 | 9 45 | 12 46 | | | | | |
| Athens. | Greece | .... | 12 0 | .... | .... | .... | .... | .... | .... | .... | .... | 12 45 | 10 25 | .... | .... | 11 45 | .... | .... | .... | .... | .... | .... | .... | .... | .... | | | | | |
| Berlin. | ..... | 11 26 | 12 41 | 12 0 | 11 36 | 11 24 | 12 23 | .... | .... | 11 34 | 11 57 | 1 6 | 11 6 | .... | .... | 12 6 | 11 53 | 6 10 | .... | 11 16 | 11 56 | 1 8 | 12 19 | .... | 12 12 | | | | | |
| Berne. | ..... | 11 50 | 1 5 | 12 24 | 12 0 | 11 48 | 12 46 | .... | .... | 11 58 | 12 20 | 1 30 | 11 30 | .... | .... | 12 30 | 12 17 | 6 34 | .... | 11 40 | 12 20 | 1 31 | 12 42 | .... | 12 36 | | | | | |
| Brussels. | ..... | 12 2 | 1 17 | 12 36 | 12 12 | 12 0 | 12 59 | .... | .... | 12 10 | 12 33 | 1 43 | 11 43 | .... | .... | 12 43 | 12 29 | 6 47 | .... | 11 52 | 12 32 | 1 44 | 12 55 | .... | 12 48 | | | | | |
| Cairo. | Egypt | .... | 11 55 | .... | .... | .... | .... | 12 0 | .... | .... | .... | 12 20 | 10 20 | .... | .... | 11 20 | .... | .... | .... | .... | .... | .... | .... | .... | .... | | | | | |
| Christiania. | Norway | .... | 1 5 | .... | .... | .... | .... | .... | 12 0 | .... | .... | 1 30 | 11 30 | .... | .... | 12 30 | .... | .... | .... | .... | .... | .... | .... | .... | .... | | | | | |
| Cologne. | Rhine | 11 52 | 1 7 | 12 26 | 12 2 | 11 50 | 12 48 | .... | .... | 12 0 | 12 22 | 1 32 | 11 32 | .... | .... | 12 32 | 12 19 | 6 36 | .... | 11 42 | 12 22 | 1 33 | 12 44 | .... | 12 38 | | | | | |
| Constant'ple. | ..... | 10 24 | 11 51 | 10 58 | 10 34 | 10 22 | 11 20 | .... | .... | 10 32 | 10 54 | 12 4 | 10 4 | .... | .... | 11 4 | 10 51 | 5 8 | .... | 10 13 | 10 54 | 12 5 | 11 16 | .... | 11 10 | | | | | |
| Copenhagen. | ..... | 11 29 | 12 44 | 12 3 | 11 40 | 11 27 | 12 26 | .... | .... | 11 38 | 12 0 | 1 10 | 11 10 | .... | .... | 12 10 | 11 56 | 6 14 | .... | 11 19 | 12 0 | 1 11 | 12 22 | .... | 12 15 | | | | | |
| Dublin. | Ireland | 12 45 | 2 0 | .... | .... | .... | .... | .... | .... | .... | .... | 2 25 | 12 25 | .... | .... | 1 25 | .... | .... | .... | .... | .... | .... | .... | .... | .... | | | | | |
| East European Time. | See above | 10 20 | 11 35 | 10 54 | 10 30 | 10 17 | 11 16 | 12 0 | 10 50 | 10 28 | 10 50 | .... | 10 0 | 12 21 | **7 40** | 11 0 | 10 46 | 5 4 | **5 0** | 10 9 | 10 50 | 12 1 | 11 12 | **8 5** | 11 6 | | | | | |
| Greenwich. | Englnd | 12 20 | 1 35 | 12 54 | 12 30 | 12 17 | 1 16 | 2 5 | 12 50 | 12 28 | 12 50 | 2 0 | 12 0 | 2 21 | **9 40** | 1 0 | 12 46 | 7 4 | 7 0 | 12 9 | 12 50 | 2 1 | 1 12 | **10 5** | 1 6 | | | | | |
| Jerusalem. | Palest. | 9 59 | 11 14 | 10 33 | 10 9 | 9 56 | 10 55 | 11 39 | 10 29 | 10 7 | 10 29 | 11 30 | 9 39 | 12 0 | **7 19** | 10 39 | 10 23 | 4 43 | **4 39** | 9 48 | 10 29 | 11 40 | 10 51 | **8 4** | 10 45 | | | | | |
| Lisbon. | Portug. | 12 56 | 2 1 | 1 30 | 1 6 | 12 54 | 1 53 | .... | .... | 1 4 | 1 27 | 2 37 | 12 37 | .... | .... | 1 37 | 1 23 | 7 41 | .... | 12 46 | 1 27 | 2 38 | 1 49 | .... | 1 42 | | | | | |
| Madrid. | ..... | 12 34 | .... | 1 8 | 12 45 | 12 32 | 1 31 | .... | .... | 12 43 | 1 5 | 2 15 | 12 15 | .... | .... | 1 15 | 1 1 | 7 19 | .... | 12 24 | 1 5 | 2 16 | 1 27 | .... | 1 20 | | | | | |
| Melbourne. | Victoria | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | 4 20 | 2 20 | .... | 12 0 | 3 20 | .... | .... | .... | .... | .... | .... | .... | .... | .... | | | | | |
| Mid-European time. | See above | 11 20 | 12 35 | 11 54 | 11 30 | 11 17 | 12 16 | 1 0 | 11 50 | 11 28 | 11 50 | 1 0 | 11 0 | 1 21 | **8 40** | 12 0 | 11 46 | 6 4 | 6 0 | 11 9 | 11 50 | 1 1 | 12 12 | **9 5** | 12 6 | | | | | |
| Moscow. | ..... | 9 49 | .... | 10 23 | 10 0 | 9 47 | 10 46 | .... | .... | 9 58 | 10 20 | 10 30 | 9 30 | .... | .... | 10 30 | 10 16 | **4 34** | .... | 9 39 | 10 20 | 11 31 | 10 42 | .... | 10 35 | | | | | |
| Munich. | ..... | 11 33 | .... | 12 7 | 11 43 | 11 31 | 12 30 | .... | .... | 11 41 | 12 4 | 1 14 | 11 14 | .... | .... | 12 14 | 12 0 | 6 18 | .... | 11 23 | 12 4 | 1 15 | 12 26 | .... | 12 19 | | | | | |
| New York. | U. S. | 5 16 | .... | 5 50 | 5 29 | 5 14 | **6 12** | .... | .... | 5 24 | 5 46 | **6** | **56** | 4 | 56 | .... | 5 42 | 12 0 | .... | 5 | 5 | 5 46 | **6 57** | **6 8** | .... | **6 2** | | | | | |
| Ottawa. | Canada. | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | **7** | **0** | 5 | 0 | **6 0** | .... | .... | 12 0 | .... | .... | .... | .... | .... | .... | | | | | |
| Paris. | France | 12 10 | .... | 12 44 | 12 20 | 12 8 | 1 7 | .... | .... | 12 19 | 12 41 | 1 51 | 11 51 | .... | .... | 12 51 | 12 37 | 6 55 | .... | 12 0 | 12 41 | 1 52 | 1 3 | .... | 12 56 | | | | | |
| Rome. | ..... | 11 30 | .... | 12 4 | 11 40 | 11 28 | 12 26 | .... | .... | 11 38 | 12 0 | 1 10 | 11 10 | .... | .... | 12 10 | 11 57 | 6 14 | .... | 11 19 | 12 0 | 1 11 | 12 22 | .... | 12 16 | | | | | |
| S. Francisco. | Califor. | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | | | | | |
| St. Petersb'rg | Russia | 10 18 | .... | 10 52 | 10 29 | 10 16 | 11 15 | .... | .... | 10 27 | 10 49 | 11 59 | 9 59 | .... | .... | 10 59 | 10 45 | **5 3** | .... | 10 8 | 10 49 | 12 0 | 11 12 | .... | 11 4 | | | | | |
| Stockholm. | ..... | 11 7 | .... | 11 41 | 11 18 | 11 5 | 12 4 | .... | .... | 11 16 | 11 38 | 12 48 | 10 48 | .... | .... | 11 48 | 11 34 | **5 52** | .... | 10 57 | 11 38 | 12 49 | 12 0 | .... | 11 53 | | | | | |
| Sydney. | N.S.W. | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | **3** | **55** | 1 | **55** | **2 55** | .... | .... | .... | .... | .... | .... | .... | 12 0 | .... | | | | | |
| Vienna. | ..... | 11 14 | .... | 11 8 | 11 24 | 11 12 | 12 11 | .... | .... | 11 22 | 11 45 | 12 55 | 10 55 | .... | .... | 11 55 | 11 41 | **5 58** | .... | 11 4 | 11 45 | 12 56 | 12 7 | .... | 12 0 | | | | | |

## SUBMARINE TELEGRAPHS.*

The submarine telegraphs of the world number 1,815. Their aggregate length is nearly 221,292,441 miles; their total cost is estimated at $300,000,000, and the number of messages annually transmitted over them at more than 6,000,000. All the grand divisions of the earth are now connected by their wires, and from country to country and island to island the thoughts and words of mankind are instantaneously transmitted. Darkest Africa now converses daily with enlightened Europe or America, and the great events of the morning are known in the evening throughout the inhabited world. In August, 1902, authority was granted to the Commercial Pacific Cable Company of the United States to construct a cable line from the Pacific coast of the United States to the Hawaiian Islands, Guam, and the Philippine Islands, and the Asiatic coast, with a branch line to Japan. The first message was sent over it July 4, 1903.

The British Pacific cable was completed on October 31st and was opened for traffic on December 8th, 1902. The cable is "all British," and runs from Vancouver, on the west coast of Canada, to Fanning Island, Fiji, and Norfolk Island in the Pacific, and thence by means of two cables to New Zealand and Queensland respectively. Its total length is about 7,800 miles.

The developments in the construction, laying and operating of submarine cables and in their availability for general public use have quite kept pace with their extension throughout the civilized world. From a mere guttapercha coated wire the submarine conductor of electricity has developed in a half century into a great cable having a central copper core surrounded by numerous layers of non-conducting material and protected by a steel wire wound spirally about it, and in turn further protected by waterproof and insect-proof wrappings. From a steamer-towed ocean barge the facilities for laying have developed to a fleet of nearly fifty steam vessels, with every facility for laying, picking-up, splicing, and repairing the cable lines. From a speed rate of three words per minute, which was made on the first trans-Atlantic cables, the speed of transmission has been accelerated to fifty words per minute, and even more than that, with the automatic transmitters now coming into use with cable lines, while by the duplexing of the cables their carrying capacity is doubled. From a cost to the sender of $100 per message, which was originally charged on the first trans-Atlantic cables, the rate from New York to London and the great cities on the continent of Europe has fallen to 25 cents per word. From several hours required for the transmission of a message and receipt of a response, the time has been so reduced that messages from the Executive Mansion to the battlefield at Santiago were sent and a response received within twelve minutes, while a message sent from the House of Representatives in Washington to the House of Parliament in London in the chess match of 1898 was transmitted and the reply received in thirteen and one-half seconds.

The effect of this ready and inexpensive method of transmitting thoughts and words from continent to continent throughout the civilized world is apparent in the rapid development of international commerce since it began. The first successful cable line between the United States and Europe was put into operation in 1866. In that year our commerce with Europe amounted to $652,232,289; in 1876, to $728,959,053; in 1886, to $898,911,504; in 1896, to $1,091,682,874, and in 1898, to $1,279,739,936, while our commerce with the whole world, which in 1866 amounted to $783,671,588, had by 1902 reached the enormous sum of $2,285,000,000.

During the last seven years Germany has laid 7,375 miles of ocean cables, at a cost of about $6,000,000. In 1898 a cable, 73 miles long, was laid between Sassnitz and Trelleborg, and German Southwest Africa was connected with the existing cable system by a line 154 miles long; and in 1900 the first German-American cable was laid between Emden and New York, by the Azores, a distance of 4,813 miles. About the same time the first German cables along the Chinese coast were laid; one of these was from Tsin-tau (Kiaochau) to Chifu, 285 miles long, and the second connected the former place with Shanghai and is 438 miles. In 1901 a fifth cable connecting Germany and England was laid, as well as a

*From the Summary of Commerce and Finance for July, 1902, The figures are now somewhat larger.

telephone cable from Fehmarn to Laland. A second German cable to New York by the Azores has been commenced and will be completed before the end of 1904, while a line to Vigo, 1,300 miles in length, has been made. Germany is contemplating an extension of her cables by constructing lines between Alenado and Guam, in the Caroline Islands, and the Pelew Islands and Shanghai.

An International Telegraph Conference opened in London, May 26th, 1903, all the States adhering to the International Telegraph Convention being represented. The Conference revised the rules as to the use of code and cipher language in international telegraphy. The decision of the last Conference, that code telegraphy should, after a certain date, be limited to the words contained in the official vocabulary prepared by the International Telegraph Bureau, has been rescinded. In future, any combination of letters not exceeding ten in number will be passed as a code word, provided that it is pronounceable according to the usage of any of the languages to which code words have hitherto been limited—namely, English, French, German, Dutch, Italian, Spanish, Portu-

SUMMARY OF CABLES OWNED BY GOVERNMENT ADMINISTRATIONS.

Partly extracted from the Official Documents issued by the International Bureau of Telegraphic Administrations, Berne. With "The Electrician's" corrections to date and additions.

| Country. | No. of Cables with One or More Cores. | Length in Nautical Miles. | |
|---|---|---|---|
| | | Of Cables. | Of Conductors. |
| Argentine Republic | 13 | 59.824 | 138.544 |
| Austria | 47 | 224 250 | 235.339 |
| Bahamas | 1 | 211.000 | 211.000 |
| Belgium | [1] 2 | 54.514 | 279.856 |
| Brazil | 23 | 37.779 | 66.414 |
| British Guiana | 5 | 84.000 | 95.000 |
| British India, Indo-European Telegraph Department Government Administration | 157 | 2,168.013 | 1,711.885 |
| Bulgaria | 1 | 0.538 | 0.538 |
| Canada | 26 | 334.750 | 334.750 |
| Ceylon and India (Joint) | 2 | 66.300 | 66.300 |
| China | 1 | 113.000 | 113.000 |
| Denmark | [1] 56 | 171.100 | 880.300 |
| Dutch Indies | 7 | 891.490 | 891.490 |
| France and Algeria | [1] 56 | 4,913.824 | 5,847.200 |
| France (West Africa) | 3 | 1,567.238 | 1,567.238 |
| French Indo-China (Cochin China, Tonquin, and Amoy) | 2 | 1,697.326 | 1,697.326 |
| Germany | [1] 89 | 2,796.635 | 5,654.977 |
| Great Britain and Ireland | [1] 177 | 2,265.830 | 7,551.994 |
| Greece | 46 | 54.931 | 54.931 |
| Holland | 32 | 241.543 | 780.449 |
| Inter-Colonial System | 5 | 7,837.770 | 7,837.770 |
| Italy | 36 | 1,063.088 | 1,112.458 |
| Japan | 103 | 2,154.883 | 2,851.173 |
| Macao | 1 | 1.930 | 1.930 |
| New Caledonia | 1 | 1.000 | 1.000 |
| New South Wales | 147 | 51.789 | 108.459 |
| New Zealand | 16 | 285.682 | 290.466 |
| Norway | 322 | 291.489 | 375.787 |
| Portugal | 4 | 115.050 | 115.050 |
| Queensland | 19 | 52.100 | 67.520 |
| Russia in Europe, and the Caucasus | 12 | 328.282 | 408.387 |
| Russia in Asia | 1 | 70.157 | 70.157 |
| Senegal | 1 | 3.000 | 3.000 |
| South Australia | 3 | 49.360 | 49.360 |
| Spain | 15 | 1,771.346 | 1,771.346 |
| Sweden | [1] 17 | 208.488 | 368.431 |
| Switzerland | 2 | 9.827 | 13.400 |
| Tasmania | 4 | 4.750 | 19.000 |
| Turkey in Europe and Asia | 21 | 346.558 | 368.734 |
| Victoria | 1 | 4.500 | 4.500 |
| Western Australia | 1 | 3.750 | 3.750 |
| Total | 1,378 | 32,609.748 | 44,006.813 |

[1] Including half of Cables owned jointly with other Administrations.

guese, and Latin. Other combinations of letters will be counted at five letters to the word, the prohibition of letter cipher which has hitherto prevailed being removed. These alterations, together with a number of other changes in the detailed regulations, take effect on July 1st, 1904. The above information is taken from Reports of the Bureau of Statistics, Department of Commerce and Labor, and Hazell's Annual.

SUMMARY OF CABLES OWNED BY PRIVATE COMPANIES.

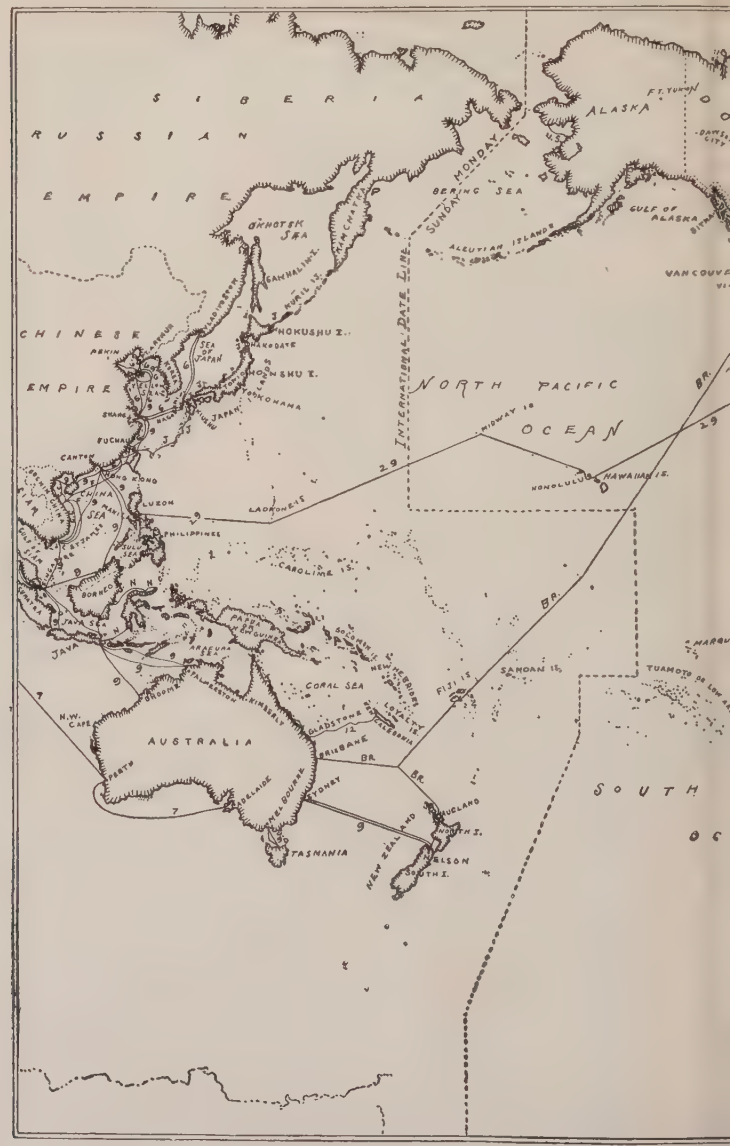
| Private Companies. | No. of Cables with One or More Cores. | Length of Cables in Nautical Miles. |
|---|---|---|
| African Direct Telegraph Company | 10 | 3,031.000 |
| Amazon Telegraph Company | 15 | 1,326.000 |
| Anglo-American Telegraph Company | 14 | 9,507.660 |
| Black Sea Telegraph Company | 1 | 337.147 |
| Canadian Pacific Railroad Company | 9 | 53.940 |
| Central and South American Telegraph Company | 15 | 7,500.500 |
| Commercial Cable Company | 11 | 13,212.310 |
| Commercial Pacific | 4 | 7,846.747 |
| Compagnie Française des Câbles Télégraphiques | 32 | 12,102.423 |
| Cuba Submarine Telegraph Company | 10 | 1,162.000 |
| Deutsch Atlantische Telegraphen-Gesellschaft | 3 | 6,057.868 |
| Deutsche See-Telegraphen-Gesellschaft | 1 | 1,111.979 |
| Direct Spanish Telegraph Company | 3 | 723.460 |
| Direct United States Cable Company | 2 | 3,099.958 |
| Direct West India Cable Company | 2 | 1,265.300 |
| Eastern Telegraph Company | 139 | 39,749.360 |
| Eastern Extension, Australasia and China Telegraph Company | 34 | 24,802.240 |
| Europe and Azores Telegraph Company | 2 | 1,053.150 |
| Eastern and South African Telegraph Company | 14 | 9,068.052 |
| Great Northern Telegraph Company | 28 | 7,003.000 |
| Halifax and Bermuda Cable Company | 1 | 849.960 |
| India Rubber, Gutta Percha and Telegraph Works Company | 2 | 137.678 |
| Indo-European Telegraph Company | 3 | 22.000 |
| Mexican Telegraph Company | 3 | 1,529.000 |
| Pacific and European Telegraph Company | | |
| River Plate Telegraph Company | 3 | 138.000 |
| South American Cable Company | 2 | 2,065.224 |
| Spanish National Submarine Telegraph Company | 1 | 927.770 |
| United States and Hayti Telegraph and Cable Company | 1 | 1,389.000 |
| West African Telegraph Company | 6 | 1,470.867 |
| West Coast of America Telegraph Company | 7 | 1,975.100 |
| West India and Panama Telegraph Company | 24 | 4,639.000 |
| [1] Western Telegraph Company | 27 | 17,283.000 |
| Western Union Telegraph Company | 8 | 7,351.000 |
| Total | 437 | 188,682.693 |

[1] Including London Platino-Brazilian and Montevidean and Brazilian Companies.

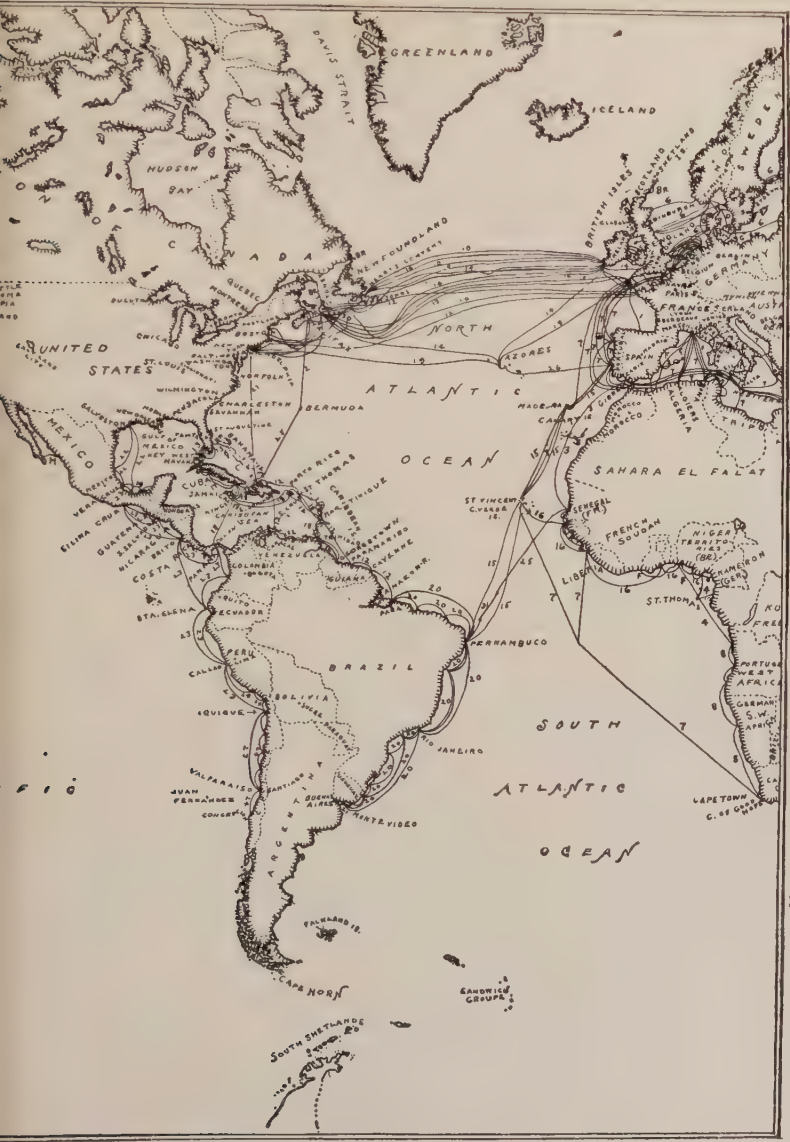
GENERAL SUMMARY.

| Ownership. | No. of Cables with One or More Cores. | Length of Cables in Nautical Miles. |
|---|---|---|
| Government Administrations | 1,378 | 32,609.748 |
| Private Companies | 437 | 188,682.693 |
| Total | 1,815 | 221,292.441 |

*—Electrical Trades Directory.*




SUBMARINE CABLE
(For explanation of letters and



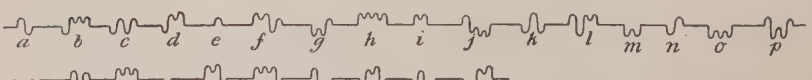

NTERNATIONAL DATE LINE.

shown on the above map, see page 199.)

## MISCELLANEOUS INFORMATION PERTAINING TO SUBMARINE TELEGRAPH LINES, THEIR CONSTRUCTION AND OPERATION, 1902.

| | |
|---|---|
| Length of first successful cable, miles | 25 |
| Length of first successful Atlantic cable, miles | 2,134 |
| Length of direct United States cable (Ballinskelligs Bay, Ireland, to Halifax, Nova Scotia), miles | 2,564 |
| Length of French cable (Brest, France, to Cape Cod, Massachusetts), miles | 3,250 |
| Distance from San Francisco to Hawaii, miles | 2,089 |
| Distance from Hawaii to Wake Island, miles | 2,040 |
| Distance from Wake Island to Guam, miles | 1,290 |
| Distance from Guam to Manila, miles | 1,520 |
| Distance from Manila to Asiatic Coast, miles | 630 |
| Depth of water in which first successful cable was laid, feet | 120 |
| Depth of Atlantic cable lines, feet | 14,000 |
| Greatest depth at which cable has been laid between Haiti and Windward Islands, feet | 18,000 |
| Greatest depth between San Francisco and Hawaii, feet | 18,300 |
| Greatest depth between Hawaii and Manila (estimated), feet | 19,600 |
| Capital of first Atlantic cable company | $1,750,000 |
| Contract price of cable for first Atlantic line | $1,125,000 |
| Contract price of cable for first successful Atlantic cable line | $3,000,000 |
| Present cost per mile of cable (estimate by Bright) | $750 |
| Cost of laying per mile, average | $375 |
| Number of words per minute sent on first line | 3 |
| Number of words per minute on first successful Atlantic cable line at beginning | 8 |
| Number of words per minute on first successful Atlantic cable line after experimental stage | 15 |
| Present rate of speed (without duplex) | 25 |
| Present rate by automatic system (without duplex) | 50 |
| Increased use of wire by duplexing, per cent | 90 |
| Number of cables laid across the North Atlantic | 16 |
| Number now working | 13 |
| Average life of cable, years | 25 |
| Original rates for messages, first Atlantic lines (minimum, 20 words or less) | $100 |
| On first reduction (minimum, 20 words or less) | $50 |
| Original word rate, without minimum | $1 |
| Present word rate, without minimum | $0.25 |
| Length of telegraph cables of the world, miles | 193,000 |
| Length of land lines of the world (1898) (estimate by Bright), miles | See page 185 |
| Cost of cable lines of the world (estimate by Bright) | $250,000,000 |
| Cost of land lines of the world (estimate by Bright) | $310,000,000 |
| Total length of telegraph wires, land and cable (estimate by Bright), miles | 2,300,000 |
| Number of cable messages sent annually (estimate by Bright) | 6,000,000 |
| Per cent of world's lines built by governments | 10 |
| Per cent built by private enterprise | 90 |
| Time of message and answer, Washington to Santiago battlefield and return, minutes | 1½ |
| Time of message, Washington to London and reply in chess match of 1898, seconds | 13½ |
| Number of cables owned by nations | 1,380 |
| Length of cables owned by nations, miles | 21,528 |
| Number of cables owned by private companies | 370 |
| Length of cables owned by private companies, miles | 171,679 |
| Longest single line without intermediate landing, miles | 3,250 |

## THE CABLE ALPHABET.




The cut above shows the Morse Code as recorded by a syphon recorder. Syphon recorders are used for receiving cable messages. It will be observed that the spaces are represented by horizontal lines, dots by loops above the space lines, and dashes by loops below the space lines.

## SUBMARINE CABLES AND INTERNATIONAL DATE LINE.

The International Date Line is an imaginary line drawn through the Pacific Ocean irregularly, but trending generally in a north and south direction. The islands of the Pacific Ocean are separated in such a way that all those which lie to the east of it carry the same date as the United States, while all those on the west of it use the same date as Japan and Australia. Our map on pages 196 and 197 shows this date line.

The submarine cable connections that are marked with letters represent the telegraph cables that are owned and operated by sovereign states. Those that are marked with numbers represent telegraph cables that are owned and operated by private companies. The explanation of the names of the countries that the letters represent and of the names of the companies that the numbers stand for is subjoined:

GOVERNMENTS.

| | | | | | |
|---|---|---|---|---|---|
| A. | Austria. | G. | Germany. | Sw. | Sweden. |
| B. | Belgium. | Gr. | Greece. | T. | Turkey. |
| Br. | Great Britain. | I. | Italy. | U. S. | United States. |
| C. | China. | J. | Japan. | P. | Portugal. |
| C. C. | Cochin China. | M. | Mexico. | R. | Russia. |
| D. | Denmark. | N. | Netherlands. | S. | Spain. |
| F. | France. | | | | |

PRIVATE COMPANIES.

1. Direct Spanish Telegraph Company.
2. Halifax and Bermuda Cable Company.
3. Spanish National Submarine Telegraph Company.
4. West African Telegraph Company.
5. Black Sea Telegraph Company.
6. Great Northern Telegraph Company.
7. Eastern Telegraph Company.
8. Eastern and South African Telegraph Company.
9. Eastern Extension, Australasia, and China Telegraph Company.
10. Anglo-American Telegraph Company.
11. Direct United States Cable Company.
12. Compagnie Française des Câbles Télégraphiques.
13. Western Union Telegraph Company.
14. The Commercial Cable Company.
15. Brazilian Submarine Telegraph Company.
16. African Direct Telegraph Company.
17. Cuba Submarine Telegraph Company.
18. West India and Panama Telegraph Company.
19. Deutsche See-Telegraphen-Gesellschaft
20. Western and Brazil Telegraph Company.
21. River Plate Telegraph Company.
22. Mexican Telegraph Company.
23. Central and South American Telegraph Company.
24. West Coast of America Telegraph Company.
25. South American Cable Company.
26. Europe and Azores Telegraph Company.
27. United States and Hayti Telegraph and Cable Company.
28. Direct West India Cable Company.
29. The Pacific Commercial Cable Company.

## WIRELESS TELEGRAPHY.

Wireless telegraphy is, in theory, closely allied to heliography, or signaling with flashes of light. The light used, however, is produced electrically and is invisible to the naked eye, owing to the fact that it is made up of very long waves, called Hertzian waves, which vibrate too slowly to affect the retina. The eye can only discern waves which make from 4,000 billions to 7,000 billions vibrations per minute. However, the Hertzian ray resembles light in that it can be reflected by a metallic plate and can be refracted by a prism of pitch, can be brought to a focus with a pitch lens, and may be polarized. Owing to the great length of the Hertzian waves, almost all substances are transparent to them. The Hertzian waves were discovered by Professor Heinrich Hertz, a young German philosopher, during his experiments with the spark discharge of Leyden jars and of the Ruhmkorff coil in 1886 and 1887.

He found that when a spark leaped the gap between the terminals, electric oscillations took place in these terminals which set up magnetic waves in the surrounding space, capable in turn of setting up similar oscillations in any adjacent conductor lying at an angle to them. The waves were detected by using a "resonator," which was merely a circle or a rectangle of copper wire formed with a gap in one side. When the induction coil was in operation and the resonator was held near the coil, a tiny stream of sparks would leap across the resonator gap. To better understand this phenomenon take as a crude example two vertical rods

in a pool of water and on each a float free to slide vertically on the rod. Now, if one of these floats be moved up and down upon its rod, it produces

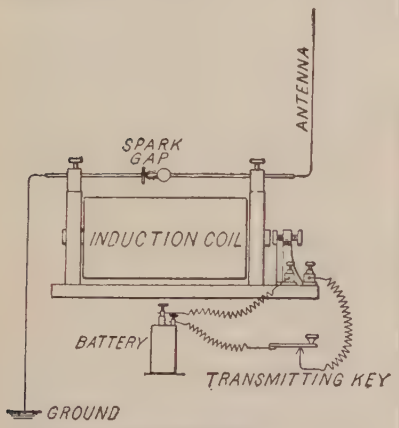
A TYPICAL WIRELESS TELEGRAPH STATION.

waves in the water just as the electric oscillation produces waves in the ether. These spread out in all directions and on reaching the other float cause it to oscillate up and down, just as the magnetic waves produce electric oscillations in the resonator.

Without going into a detailed history of the development of wireless telegraphy from Hertz's experiments, it may be stated that the essential difference between the apparatus used by Hertz in his experiments and the several systems now commonly in use lies in the receiver. The transmitter is practically the same. A vertical wire called the antenna is connected to one terminal of the coil, and the other terminal is connected with the earth, the purpose being to increase the electrical capacity of the terminal rods and produce larger waves. Instead of producing the oscillations by means of an induction coil, they are now ordinarily produced by a dynamo and a step-up transformer except for telegraphing over short distances. But even with these changes we would not be able to telegraph over any appreciable distance if dependent upon the Hertz resonator for receiving a message, for, owing to the fact that the waves spread out in all directions from the transmitting antenna, the receiving antenna is acted upon by a very small proportion of the power expended by the transmitter, and this proportion decreases very rapidly as the distance between the transmitter and the receiver increases. In order then to detect the rays at long distances, a very sensitive instrument called the "coherer" has been invented. The coherer in its usual form consists of a glass tube with two metal pistons fitted therein between which a quantity of nickel filings is placed. The latter forms an imperfect electrical contact between the pistons, and takes the place of the spark gap in the receiving antenna. When the oscillations are set up in the antenna by the Hertzian waves, due to their high pressure or voltage, they break through the imperfect contact of the coherer, causing the filings therein to cohere or string together and thus produce a much better electric path through the coherer. The action is microscopic and cannot be detected with the naked eye. However, the coherer, aside from being a part of the antenna circuit, is also made a part of a local battery circuit, which contains a telegraph receiver, and whenever the electric oscillations open a good path through the filings for the local circuit, the telegraph instrument will be energized by the local battery only. In order to break this path after the oscillations

have ceased, or, in other words, to cause the filings to decohere, they are constantly jarred apart by means of the "tapper," which is in reality an electric bell with the gong removed and the clapper striking the coherer tube instead. Carbon granules may be substituted for metallic filings, and in this case no tapper is necessary, the coherer being self-restoring.

In transmitting messages a telegraph key in the primary circuit of the induction coil is operated according to the usual Morse code, and this causes sparks to leap the spark gap at corresponding intervals. These signals will then be transmitted by the Hertzian waves to the receiving station, where they will be recorded by the telegraph

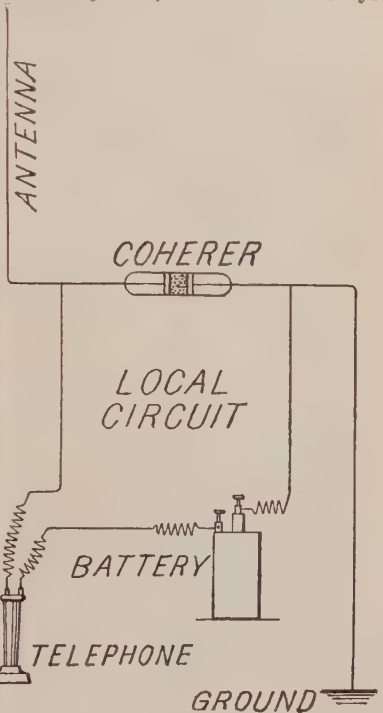



TRANSMITTER.

receiver. The coherer is not by any means the only wave detector in use. Every wireless telegraph company has one or more different types of detectors, but for the most part they are all based on the principle of the imperfect contact. Marconi's "magnetic detector" is a notable exception. The present efforts of inventors in the field of wireless telegraphy are directed mainly to the development of a system which will not allow one equipment to interfere with or suffer interference from any other equipment. This is essential in order to prevent unauthorized persons from intercepting and reading the messages. They aim to effect this result by syntonizing or tuning the transmitting and receiving stations so that they will give oscillations and respond to oscillations of a certain periodicity only. Up to the present time these efforts have met with only partial success.

### PRINCIPAL SYSTEMS OF WIRELESS TELEGRAPHY.

The best known systems of wireless telegraphy in the United States are the Marconi, the De Forest and the Fessenden systems, and one or two sys-




RECEIVER.

tems used by the Government. In England, aside from the Marconi system, are the Lodge-Muirhead and the Orling-Armstrong systems. The Slaby-Arco and the Braun-Siemens-Halske systems are used in Germany. In France, Branley, Rochefort, Tissot and Captain Ferrie have made important developments, and in Russia Popoff early invented a system very similar to that of Marconi.

### THE MARCONI SYSTEM.

The Marconi system, developed by Signor Guglielmo Marconi, a young

Italian inventor, is the pioneer system of Hertzian wave telegraphy. In 1896 Marconi accepted an invitation from the British Telegraph Department to make experiments with his system in England. In the spring of 1899 the first wireless message was transmitted across the English channel. On November 15, 1899, the first daily newspaper ever published on an Atlantic liner was issued on the steamer St. Paul, containing news transmitted from shore by wireless telegraphy. In 1900 the system was adopted by the British Admiralty and installed on their battleships and cruisers. On December 12, 1901, Marconi succeeded in sending the signal for the letter "S" across the Atlantic from Poldhu, Cornwall, to St. John's, Newfoundland. But his experiments were interrupted by a cable company which owned a monopoly of all telegraph communications with Newfoundland. In March, 1902, Marconi crossed the Atlantic on the "Philadelphia," which had been equipped with his instruments, and was able to receive intelligible messages at a distance of 1,551 miles from the Poldhu station. In October of the same year Marconi sailed from England to Nova Scotia, and received messages from his Poldhu station throughout the voyage. On January 18, 1903, the first wireless message from the United States to England was sent by President Roosevelt to King Edward. In March, 1903, the Marconi Company undertook to furnish the London "Times" with daily wireless despatches from the United States, but they were discontinued after a couple of despatches had been sent. The Italian Government, in 1903, voted $160,000 for the erection of a Marconi station in Italy to communicate with this country.

## STATIONS EQUIPPED WITH MARCONI APPARATUS.

BELGIUM.
- Nieuport.

CANADA.
- Sydney, N. S.
- Cape Breton.
- Indian Harbor, Labrador.
- Domino, Labrador.
- Seal Island, Labrador.
- Venison Island, Labrador.
- Battle Harbor, Labrador.
- Chateau Bay, Labrador.
- Belle Isle, Labrador.
- Point Amour, Labrador.
- Heath Point, Quebec.
- Fame Point, New Brunswick.
- Cape Ray, Newfoundland.
- Cape Race, Newfoundland.
- Cape Sable, Nova Scotia.
- Whittle Rock, Labrador.
- Sable Island, Nova Scotia.
- Point Rich, Newfoundland.
- St. John, New Brunswick.
- Halifax, Nova Scotia.

CHINA.
- Pekin.
- Tientsin.
- Hongkong.

CONGO FREE STATE.
- Banana.
- Ambrizette.

GERMANY.
- Borkum Isle.
- Borkum Riff.

GREAT BRITAIN & IRELAND (List incomplete).
- Caister.
- Chelmsford.
- Fraserburgh.
- Frinton.
- Haven Poole Harbor.
- Holyhead.
- Poldhu.
- Withernsea.
- North Foreland.
- Malta.

GREAT BRITAIN & IRELAND—*Continued.*
- Seaforth.
- Liverpool.
- Lizard.
- Broomfield.
- Gibraltar.
- Rosslare.
- Niton, I. W.
- Fastnet Rock.
- Malin Head.
- Inishtrahull.
- Culver Cliff.
- Dover.
- Plymouth.
- Portland.
- Portsmouth.
- Rane Head.
- Roches Point.
- Scilly Islands.
- Sheerness.

HOLLAND.
- Amsterdam (Overtoom).

ITALY (List incomplete).
- Darignano.
- Genoa.
- Gulf of Aranci.
- Maddalena.
- Monte Mario.
- Palmaria.
- Pisa.
- Punta di Bela.
- Rome.
- San Vito.
- Bari.

MONTENEGRO.
- Antivari.

UNITED STATES.
- Great Neck, L. I.
- Siascouset, L. I.
- Nantucket, Mass.
- Sagaponack, L. I.
- So. Wellfleet, Mass.
- Babylon, L. I.
- New York City.

On the preceding page is a list of stations equipped with Marconi apparatus and operated under arrangement with stations owned and controlled by Marconi Wireless Telegraph Company of America and affiliated Marconi companies.

The following is a list of Transatlantic liners equipped with Marconi apparatus:

CUNARD STEAMSHIPS.—Campania, Etruria, Ivernia, Lucania, Umbria, Saxonia, Aurania, Carpathia, Slavonia, Pannonia, Ultonia, Caronia.

RED STAR LINE.—Zeeland, Vaderland, Finland, Kroonland.

HAMBURG-AMERICAN LINE.—Deutschland, Moltke, Blucher, Hamburg.

ISLE OF MAN STEAM PACKET CO.—Empress Queen.

ATLANTIC TRANSPORT CO.—Minneapolis, Minnehaha, Minnetonka.

ANCHOR LINE.—Caledonia, Columbia.

CANADIAN GOVERNMENT.—Minto, Stanley, Canada.

WHITE STAR LINE.—Oceanic, Majestic, Celtic, Cedric, Baltic, Teutonic.

AMERICAN LINE.—Philadelphia, St. Louis, St. Paul, New York.

BELGIAN MAIL PACKET.—Princess Clementine, Flandre, Princesse Henriette, Princesse Josephine, Leopold II., Marie Henriette, Prince Albert, Rapide, Ville de Douvres.

CAMPAGNIA DI NAVIGAZIONE "LA VELOCE."—Citta di Napoli, Sud America.

COMPAGNIE TRANS-ATLANTIQUE.—La Savoie, La Lorraine, La Touraine, La Bretagne, La Gascogne.

HOLLAND AMERICAN LINE.—Rotterdam, Potsdam, Ryndam, Noordam, Statendam.

NORDDEUTSCHER LLOYD.—Kaiser Wilhelm der Grosse, Kronprinz Wilhelm, Kaiser Wilhelm II., Grosser Kurfurst.

ALLAN LINE.—Tunisian, Parisian, Bavarian, Victorian, Virginian.

NAVIGAZIONE GENERALE ITALIANA.—Sardegna, Liguria, Lombardia, Sicilia, Umbria.

All commissioned ships of British and Italian Royal Navies are equipped with the Marconi apparatus.

### THE DE FOREST SYSTEM.

The American De Forest Wireless Telegraph Company has developed from the inventions of Dr. Lee de Forest, a young Yale graduate. His system differs from that of Marconi chiefly in the receiver. At first an instrument called the "anti-coherer," or "responder," was used in place of the coherer. The action of this instrument was just the reverse of the coherer, that is, a good path was normally provided for the local circuit, but this path was broken by the electric oscillations in the antenna. The anti-coherer was later replaced by another instrument, which acts electrolytically to a large extent. This instrument, like the coherer, normally offers a resistance to the current in the local circuit, but this resistance is broken down by the electric oscillations in the antenna. Another difference between the systems lies in the fact that the De Forest company uses a telephone receiver in the local circuit instead of the telegraph receiver for receiving the signals. Signals by the De Forest system can be transmitted at the rate of twenty-five to thirty words per minute. The De Forest Company has established a score of stations along the Atlantic coast, and several along the Great Lakes. Late in 1903 the De Forest Company entered into a contract with the London "Times" to furnish news of the Russo-Japanese war. The steamer "Haimun" was equipped with wireless telegraph apparatus, and rendered valuable service in reporting naval operations and engagements. These reports were sent by wireless telegraphy to Wei-hai-Wei and thence by cable to London. In July, 1904, the United States Government closed a contract with the De Forest Company for a series of stations in the West Indies and Panama. These, it is stated, are to form links in a chain of De Forest stations which will connect New England with Japan, China and the Philippines. The chain is to follow the Atlantic coast to Key West, and thence run via Porto Rico to Panama. From Panama it will follow the Pacific coast to Seattle, thence via the Aleutian Islands to Japan, Wei-hai-Wei, China and the Philippines, returning to San Francisco through Guam and Hawaii. Under the terms of the contract, commercial messages are to be interchangeable between all stations equipped with the De Forest system, whether operated by the Government or the De Forest Company.

The following is a list of wireless telegraph stations, equipped with De Forest apparatus, and now complete and in operation for the transmission of wireless messages:

## STATIONS AND SHIPS EQUIPPED WITH THE DE FOREST WIRELESS TELEGRAPH SYSTEM.

### Stations Operated by the De Forest Companies.

Atlantic Coast Stations.
- Portland, Maine.
- Boston, Mass.
- Providence, R. I.
- New Haven, Conn.
- Bridgeport, Conn.
- New York.
- Manhattan Beach, L. I.
- Quogue, L. I.
- Philadelphia, Pa.
- Galilee, N. J.
- Atlantic City, N. J.
- Washington, D. C.
- Cape Hatteras, N. C.
- Charleston, N. C.
- Savannah, Ga.
- Key West, Fla.
- Mobile, Ala.
- New Orleans, La.
- Galveston, Texas.
- Havana, Cuba.

Interior Stations.
- Hartford, Conn.
- Springfield, Mass.
- Paterson, N. J.
- Buffalo, N. Y.
- Bay View, N. Y.
- Cleveland, Ohio.
- Chicago, Ill.
- Springfield, Ill.
- St. Louis, Mo.
- Kansas City, Mo.
- Dallas, Texas.

Interior Stations—*Continued.*
- Fort Worth, Texas.
- Denver, Colo.
- Colorado Springs, Colo.
- Cripple Creek, Colo.
- Pueblo, Colo.
- Pikes' Peak, Colo.

Pacific Coast Stations.
- San Francisco, Cal.
- Seattle, Washington.

Canadian Stations.
- Toronto, Ont.
- Hamilton, Ont.
- Ottawa, Ont.
- Montreal, Quebec.
- Quebec, Quebec.

Brazilian Stations.
- Rio Janeiro and three others.

U. S. Government (Navy Department).
- Key West, Florida.
- Pensacola, Florida
- Guantanamo, Cuba.
- San Juan, Porto Rico.
- Colon, Panama.
- U. S. S. Colorado.
- U. S. S. West Virginia.

U. S. Government (Signal Corps).
- Cape Nome, Alaska.
- St. Michael's, Alaska.

United Fruit Company.
- Port Limon, Costa Rica.
- Boca del Toro, Panama.

### Merchant Ships Equipped with De Forest System.

Mallory S. S. Line.
- S. S. Denver.
- S. S. Concho.

Red D Line.
- S. S. Philadelphia.
- S. S. Caracas.

New York and Porto Rico S. S. Company.
- S. S. Coamo.
- S. S. Ponce.

Savannah Line.
- S. S. City of Atlanta.
- S. S. City of Columbus

Maine S. S. Company.
- S. S. North Star.
- S. S. Horatio Hall.

P. & O. Steamship Company.
- S. S. Olivette.
- S. S. Mascotte.

Quebec S. S. Company.
- S. S. Trinidad.
- S. S. Bermudian.

Standard Oil Company.
- S. S. Capt. A. F. Lucas.
- S. S. Col. E. L. Drake.
- S. S. Maverick,
- S. S. Astral.
- Barge 92.
- Barge 95.

Consolidated Coal Co. (B. & O. R. R.)
- Tug Savage.

On the Great Lakes.
- S. S. City of Erie.
- S. S. Wolvin.

# FLAGS AND PENNANTS TO BE USED IN THE INTERNATIONAL CODE.

"Code Flag" and "Answering Pennant."

When used as the "Code Flag" it is to be hoisted under the ensign.

When used as the "Answering Pennant" it is to be hoisted at the masthead or where best seen.

To open communication by the old Code, show the ensign with the pennant under it,

## INTERNATIONAL WIRELESS TELEGRAPHY CONFERENCE.

On account of the rival systems in use in this country and the different countries of Europe, it was decided to hold an international conference, at which rules could be formulated to control them. The conference met at Berlin in August, 1903. The following rules were adopted, applying to the exchange of messages between vessels at sea and coast stations:

Any fixed station whose field of action extends to the sea is styled a coast station.

Coast stations are bound to receive and transmit telegrams originating from or intended for vessels at sea without any distinction of wireless telegraph system used by the latter.

Contracting parties shall publish any technical information likely to facilitate or expedite communication between coast stations and ships at sea.

The wireless station must, unless it should be absolutely impossible, accept in preference requests for help that may come from vessels.

The service of wireless telegraph stations must be organized as far as practicable so as not to interfere with the service of other stations.

The protocol was signed by the United States, Germany, Austria, Spain, France and Russia. Great Britain and Italy were unable to sign. The general feeling of the conference was decidedly against monopolization of the wireless telegraph business by any one company.

## NEW INTERNATIONAL CODE OF SIGNALS.

The new International Code of Signals came into use on January 1, 1901, and its distinguishing sign will henceforward be the code pennant hoisted in the ordinary way.

Illustrations of the new signals are given in the plate, together with rules for signals of distress in the text.

It is not now necessary to tie the fly of the Code Pennant to the halyards, as was previously required when beginning to signal. When hoisted under the ensign, it denotes a signal taken from the International Code. When hoisted by itself at the masthead it is the Answering Pennant.

Communication may then be commenced, and any message following in this page, or found under the heading "Danger or Distress" in the International Code Signal Book, may be exchanged, strictly following the International Commercial Code and the instructions given above.

The International Code Signal described above, asking to open communication, should be shown in every case of distress by the shore station, for it may be that the vessel has the International Code, but, until seeing this signal, will not know that she can use it.

### SIGNALS ADOPTED FROM AND TO BE FOUND IN INTERNATIONAL COMMERCIAL CODE SIGNAL BOOK OF 1899, REFERRED TO ABOVE.

| | |
|---|---|
| N C | In distress; want immediate assistance. |
| D C | We are coming to your assistance. |
| E Y | Do not attempt to land in your own boats. |
| B I | Damaged rudder; can not steer. |
| B J | Engines broken down; I am disabled. |
| J D | You are standing into danger. |
| F Z | Heavy weather coming; look sharp. |
| F R | Bar is impassable. |
| I E D | Cast off. |
| R I F | Make fast—to— |
| W F Q | Slack away. |
| K T | Shift your berth. Your berth is not safe. |
| K P | Hold on until high water. |
| K H | Remain by the ship. |
| A B | Abandon the vessel as fast as possible. |
| K D | Landing is impossible. |
| K F | Look out for rocket line (*or*, line). |
| K A | Endeavor to send a line by boat (cask, kite, raft, etc.). |
| C X | No assistance can be rendered; do the best you can for yourselves. |
| K G | Lookout will be kept on the beach all night. |

## INTERNATIONAL COMMERCIAL CODE SIGNALS—*Continued.*

| | |
|---|---|
| K E | Lights, *or* Fires will be kept at the best place for coming on shore. |
| K C | Keep a light burning. |
| A D | Do not abandon the vessel until the tide has ebbed. |
| N M | I am on fire. |
| N O | I am sinking (*or*, on fire); send all available boats to save passengers and crew. |
| Y F | Want assistance; mutiny. |
| Y L | Want immediate medical assistance. |
| Y G | Want a boat immediately (*if more than one, number to follow*). |
| Y P | Want a tug (*if more than one, number to follow*). |
| A G | I must abandon the vessel. |
| P T | Want a pilot. |
| V G | What is name of ship or Signal Station in sight? |
| D U | Repeat ship's name; your flags were not made out. |
| W C X | Signal not understood, though the flags are distinguished. |
| N C X | I can not make out the flags (*or*, signals). |
| C | Assent—Yes. |
| D | Negative—No. |

## DISTRESS SIGNALS.

(Article 31 of International Rules.)

When a vessel is in distress and requires assistance from other vessels or from the shore the following shall be the signals to be used or displayed by her, either together or separately, namely:

In the daytime—

(1) A gun or other explosive signal fired at intervals of about a minute

(2) The International Code signal of distress indicated by N C.

(3) The distance signal, consisting of a square flag, having either above or below it a ball or anything resembling a ball.

(4) The distant signal, consisting of a cone, point upward, having either above it or below it a ball or anything resembling a ball.

(5) A continuous sounding with any fog-signal apparatus.

At night—

(1) A gun or other explosive signal fired at intervals of about a minute.

(2) Flames on the vessel (as from a burning tar barrel, oil barrel, and so forth).

(3) Rockets or shells throwing stars of any color or description, fired one at a time, at short intervals.

(4) A continuous sounding with any fog-signal apparatus.

## LIST OF WEATHER BUREAU STATIONS ON THE UNITED STATES SEACOAST TELEGRAPHIC LINES.

ATLANTIC COAST.
- Nantucket, Massachusetts.
- Narragansett Pier, Rhode Island.
- Block Island, Rhode Island.
- Norfolk, Virginia.
- Cape Henry, Virginia.
- Currituck Inlet, North Carolina.
- Kitty Hawk, North Carolina.
- Hatteras, North Carolina.
- Sand Key, Florida.

PACIFIC COAST.
- Tatoosh Island, Washington.
- Neah Bay, Washington.
- East Clallam, Washington.
- Twin Rivers, Washington.
- Port Crescent, Washington.
- North Head, Washington.
- Point Reyes Light, California.
- San Francisco, California.
- Southeast Farallone, California.

LAKE HURON.
- Thunder Bay Island, Michigan.
- Middle Island, Michigan.
- Alpena, Michigan.

Of the above stations the following, and also Jupiter, Florida, are supplied with International Code Signals, and communication can be had therewith for the purpose of obtaining information concerning the approach of storms, weather conditions in general, and for the purpose of sending telegrams to points on commercial lines.

- Nantucket, Massachusetts.
- Block Island, Rhode Island.
- Cape Henry, Virginia.
- Kitty Hawk, North Carolina.
- Sand Key, Florida.
- Tatoosh Island, Washington.
- Hatteras, North Carolina.
- Neah Bay, Washington.
- Point Reyes Light, California.
- Southeast Farallone, California.

Any message signaled by the International Code, as adopted or used by England, France, America, Denmark, Holland, Sweden, and Norway, Russia, Greece, Italy, Germany, Austria, Spain, Portugal, and Brazil, received at these telegraphic signal stations, will be transmitted and delivered to the address on payment at the station of the telegraphic charge. All messages received from or addressed to the War, Navy, Treasury, State, Interior, or other official department at Washington, are telegraphed without charge over the Weather Bureau lines.

## SPECIAL DISTANT SIGNALS.

Made by a single hoist followed by the STOP signal. Arranged numerically for reading off a signal.

THESE SIGNALS MAY BE MADE BY THE SEMAPHORE, BY CONES, BALLS AND DRUMS, OR BY SQUARE FLAGS, BALLS, PENNANTS AND WHEFTS.

| Signal. | Meaning. |
|---|---|
| | 2 "Preparative," "Answering," *or*, "Stop," after each complete signal. |
| | 1 2 Aground; want immediate assistance. |
| | 2 1 Fire, *or*, Leak; want immediate assistance. |
| | 2 2 Annul the whole signal. |
| | 2 3 You are running into danger, *or*, Your course is dangerous. |
| | 2 4 Want water immediately. |
| | 3 2 Short of provisions; starving. |
| | 4 2 Annul the last hoist; I will repeat it. |
| | 1 1 2 I am on fire. |
| | 1 2 1 I am aground. |

| Signal. | Meaning. |
|---|---|
| | 1 2 2 Yes, *or*. Affirmative. |
| | 1 2 3 No, *or*, Negative. |
| | 1 2 4 Send lifeboat. |
| | 1 3 2 Do not abandon the vessel. |
| | 1 4 2 Do not abandon the vessel until the tide has ebbed. |
| | 2 1 1 Assistance is coming. |
| | 2 1 2 Landing is impossible. |
| | 2 1 3 Bar, *or*, Entrance is dangerous. |
| | 2 1 4 Ship disabled; will you assist me into port? |
| | 2 2 1 Want a pilot. |
| | 2 2 3 Want a tug; can I obtain one? |
| | 2 2 4 Asks the name of ship (*or*, signal station) in sight, *or*, Show your distinguishing signal. |

| Signal. | Meaning. |
|---|---|
| | 2 3 1 Show your ensign. |
| | 2 3 2 Have you any dispatches (message, orders, *or*, telegrams) for me? |
| | 2 3 3 Stop, Bring-to, *or*, Come nearer; I have something important to communicate. |
| | 2 3 4 Repeat signal, or hoist it in a more conspicuous position. |
| | 2 4 1 Can not distinguish your flags; come nearer, or make Distant Signals. |
| | 2 4 2 Weigh, Cut, *or*, Slip; wait for nothing; get an offing. |
| | 2 4 3 Cyclone, Hurricane, *or*, Typhoon expected. |
| | 3 1 2 Is war declared, *or*, Has war commenced? |
| | 3 2 1 War is declared, *or*, War has commenced. |
| | 3 2 2 Beware of torpedoes; channel is mined. |
| | 3 2 3 Beware of torpedo boats. |
| | 3 2 4 Enemy is in sight. |

3 3 2 Enemy is closing with you, *or*, You are closing with the enemy.

3 4 2 Keep a good look-out, as it is reported that enemy's men-of-war are going about disguised as merchantmen.

4 1 2 Proceed on your voyage.

The information relative to the International Code is taken from the thirty-fifth annual list of the merchant vessels of the United States and is published by the Bureau of Navigation, Department of Commerce and Labor.

THE FOLLOWING DISTANT SIGNALS MADE WITH FLAG AND BALL, OR PENNANT AND BALL, HAVE THE SPECIAL SIGNIFICATION INDICATED BENEATH THEM.

| | | | |
|---|---|---|---|
| | | | |
| You are running into danger. | Fire, *or*, Leak; want immediate assistance. | Short of provisions. Starving. | Aground; want immediate assistance. |

## SEMAPHORES.

There are many semaphores established on the French, Italian, Portuguese, and some on the Spanish and Austrian coasts, where only the international Code of Signals is now used. Where practicable these semaphores have means of communicating by telegraph with each other and with the chief metropolitan lines and foreign stations.

Passing ships are able to exchange communication with the semaphores, and when required their messages are forwarded to their destination according to the fixed tariff. On the coasts of Great Britain there are signal stations which offer the same facilities to passing vessels.

## BOAT SIGNALS.

The Symbols for Boat Signals are—

1. Two *square* flags, or handkerchiefs, or pieces of cloth.

2. Two long strips of cloth, or parts of a plank, or pieces of wood longer than broad.

3. Two balls or hats, or round bundles, or buckets.

With these any of the Distance Signals can be made—holding the Symbol at arm's length; and the Signal is to be *made from right to left* and *read from left to right*, thus:

Equivalent to Ball above Pennant, or, "You are running into danger."

In making Boat Signals it is important to use only the proper means to attract attention, and to avoid those that may occasion confusion or misinterpretation.

## CYCLONES.

[Pilot Chart, Hydrographic Office.]

"RULE 1.—*If the squalls freshen without any shift of wind*, you are on or near the storm track: heave to on the starboard tack and watch for some indications of a shift, observing the low clouds particularly; if the barometer fall decidedly (say half an inch) without any shift, and if wind and sea permit, run off with the wind on the starboard quarter and keep your compass course.

"RULE 2.—*If the wind shift to the right*, you are to the right of the storm track. put the ship on the starboard tack and make as much headway as possible until obliged to lie-to (starboard tack).

"RULE 3.—*If the wind shift to the left*, you are to the left of the storm track: bring the wind on the starboard quarter and keep your compass course if obliged to lie-to, do so on the port tack.

"GENERAL RULES, GOOD FOR ALL NORTHERN HEMISPHERE STORMS.—In scudding always keep the wind well on the starboard quarter, in order to run out of the storm. Always lie-to on the coming-up tack. Use oil to prevent heavy seas from breaking on board."

## LIFE-SAVING SIGNALS.

The following signals recommended by the late International Marine Conference for adoption by all institutions for saving life from wrecked vessels, have been adopted by the Life-saving Service of the United States.

1. Upon the discovery of a wreck by night, the life-saving force will burn a red pyrotechnic light or a red rocket to signify, "You are seen; assistance will be given as soon as possible."

2. A red flag waved on shore by day; or a red light, red rocket, or red Roman candle displayed by night, will signify, "Haul away."

3. A white flag waved on shore by day, or a

white light slowly swung back and forth, or a white rocket or white Roman candle fired by night, will signify, "Slack away."

4. Two flags, a white and a red, waved at the same time on shore by day, or two lights, a white and a red, slowly swung at the same time, or a blue pyrotechnic light burned by night, will signify, "Do not attempt to land in your own boats; it is impossible."

5. A man on shore beckoning by day, or two torches burning near together by night, will signify, "This is the best place to land."

## THE WEATHER BUREAU.

The Weather Bureau furnishes, when practicable, for the benefit of all interests dependent upon weather conditions, the "Forecasts" which are prepared daily at the Central Office in Washington, D. C., and certain designated stations. These forecasts are telegraphed to stations of the Weather Bureau, railway officials, postmasters and many others, to be communicated to the public by means of flags or steam whistles. The flags adopted for this purpose are five in number, and of the forms and colors indicated below:

EXPLANATION OF WEATHER FLAGS.

When number 4 is placed above number 1, 2 or 3 it indicates warmer; when below, colder; when not displayed, the temperature is expected to remain about stationary. During the late spring and early fall the cold-wave flag is also used to indicate anticipated frosts.

EXPLANATION OF WHISTLE SIGNALS.

A warning blast of from fifteen to twenty seconds duration is sounded to attract attention. After this warning the longer blasts (of from four to six seconds duration) refer to weather, and shorter blasts (of from one to three seconds duration) refer to temperature; those for weather are sounded first.

| *Blasts.* | *Indicate.* |
|---|---|
| One long | Fair weather. |
| Two long | Rain or snow. |
| Three long | Local rain or snow. |
| One short | Lower temperature. |
| Two short | Higher temperature. |
| Three short | Cold wave. |

By repeating each combination a few times, with intervals of ten seconds, liability to error in reading the signals may be avoided.

As far as practicable the forecast messages will be telegraphed at the expense of the Weather Bureau; but if this is impracticable, they will be furnished at the regular commercial rates and sent "collect." In no case will the forecasts be sent to a second address in any place except at the expense of the applicant.

Persons desiring to display the flags or sound the whistle signals for the benefit of the public should communicate with the Weather Bureau officials in charge of the climate and crop service of their respective States, the central stations of which are as follows:

Montgomery, Ala.; Phœnix, Ariz.; Little Rock, Ark.; San Francisco, Cal.; Denver, Colo.; Jacksonville, Fla.; Atlanta, Ga.; Boise, Idaho; Springfield, Ill.; Indianapolis, Ind.; Des Moines, Iowa; Topeka, Kan.; Louisville, Ky.; New Orleans, La.; Baltimore, Md. (for Delaware and Maryland); Boston, Mass. (for New England); Lansing, Mich.; Minneapolis, Minn.; Vicksburg, Miss.; Columbia, Mo.; Helena, Mont.; Lincoln, Nebr.; Carson City, Nev.; New Brunswick, N. J.; Santa Fe, N. Mex.; Ithaca, N. Y.; Raleigh, N. C.; Bismarck, N. Dak.; Columbus, Ohio; Oklahoma, Okla. (for Oklahoma and Indian Territories); Portland, Oreg.; Philadelphia, Pa.; Columbia, S. C.; Huron, S. Dak.; Nashville, Tenn.; Galveston, Tex.; Salt Lake City, Utah; Richmond, Va.; Seattle, Wash.; Parkersburg, W. Va.; Milwaukee, Wis.; Cheyenne, Wyo.

WILLIS L. MOORE,
Chief U. S. Weather Bureau.

# CHAPTER IX.

## PATENTS, TRADE MARKS, COPYRIGHTS.

### PATENTS IN RELATION TO MANUFACTURES.

The value of our patent system is eloquently outlined by Senator Platt, of Connecticut. In speaking on a bill for the reorganization of the Patent Office, he said:

"To my mind, the passage of the act of 1836 creating the Patent Office marks the most important epoch in the history of our development—I think the most important event in the history of our Government from the Constitution until the Civil War. The establishment of the Patent Office marked the commencement of that marvelous development of the resources of the country which is the admiration and wonder of the world, a development which challenges all history for a parallel; and it is not too much to say that this unexampled progress has been not only dependent upon, but has been coincident with, the growth and development of the patent system of this country. Words fail in attempting to portray the advancement of this country for the last fifty years. We have had fifty years of progress, fifty years of inventions applied to the every-day wants of life, fifty years of patent encouragement, and fifty years of a development in wealth, resources, grandeur, culture, power which is little short of miraculous. Population, production, business, wealth, comfort, culture, power, grandeur, these have all kept step with the expansion of the inventive genius of the country; and this progress has been made possible only by the inventions of its citizens. All history confirms us in the conclusion that it is the development by the mechanical arts of the industries of a country which brings to it greatness and power and glory. No purely agricultural, pastoral people ever achieved any high standing among the nations of the earth. It is only when the brain evolves and the cunning hand fashions labor-saving machines that a nation begins to throb with new energy and life and expands with a new growth. It is only when thought wrings from nature her untold secret treasures that solid wealth and strength are accumulated by a people."

When the Japanese Government was considering the establishment of a patent system, they sent a commissioner to the United States and he spent several months in Washington, every facility being given him by the Commissioner of Patents. One of the examiners said: "I would like to know why it is that the people of Japan desire to have a patent system."

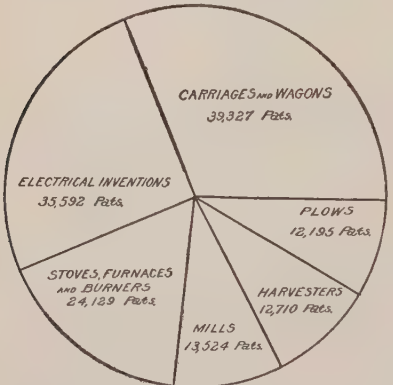
"I will tell you," said Mr. Takahashi. "You know it is only since Commodore Perry, in 1854, opened the ports of Japan to foreign commerce that the Japanese have been trying to become a great nation, like other nations of the earth, and we have looked about us to see what nations are the greatest, so that we could be like them; and we said, 'There is the United States, not much more than a hundred years old, and America was not discovered by Columbus yet four hundred years ago'; and we said, 'What is it that makes the United States such a great nation?' And we investigated, and we found it was patents, and we will have patents."

The examiner, in reporting this interview, added: "Not in all history is there an instance of such unbiased testimony to the value and worth of the patent system as practiced in the United States."

The demonstration thus given the commercial world during the last half century of the effect of beneficent patent laws has led to their modification in all the chief industrial countries, and the salient feature of our system—a preliminary examination as to novelty and patentability prior to the grant of a patent—has in late years been incorporated into the patent systems of many foreign countries, as, for instance, Austria, Canada, Den-

mark, Germany, Japan, Norway, Russia, Sweden, and Switzerland.

The discoverer of new products of value in the arts and the inventor of new processes, or improved machines, adds to public wealth, and his right to the product of his brain is now recognized by the laws of all civilized nations. The word "patent" had its origin in royal grants to favored subjects of monopolies in trade or manufacture; but now the word is used in a restricted sense to cover improvements in inventions. A few patents for inventions were granted by the provincial governments of the American colonies and by the legislatures of the States, prior to the adoption of the




PRINCIPAL FIELDS OF INVENTIVE ENDEAVOR.

Federal Constitution. On the 5th of September, 1787, it was proposed to incorporate in a constitution a patent and copyright clause. The germinating principle of this clause of the Constitution has vitalized the nation, expanded its powers beyond the wildest dreams of its fathers, and from it more than from any other cause, has grown the magnificent manufacturing and industrial development which we to-day present to the world.

In the early days the granting of a patent was quite an event in the history of the State Department, where the clerical part of the work was then performed. It would be interesting to see Thomas Jefferson, the Secretary of War, and the Attorney-General, critically examining the application and scrutinizing each point carefully and rigorously. The first year the majority of the applications failed to pass the ordeal, and only three patents were granted. In those days every step in the issuing of a patent was taken with great care and caution, Mr. Jefferson always seeking to impress upon the minds of his officers and the public that the granting of a patent was a matter of no ordinary importance. Prior to 1836 there was no critical examination of the state of the art preliminary to the allowance of a patent application. Since the act of 1836 there have been various enactments modifying and improving the law in matters of detail. In 1861 the term for a patent was increased from fourteen to seventeen years, and in 1870 the patent law was revised, consolidated and amended; but in its salient features the patent system of today is that of the law of 1836. The subject of patents is admirably treated by Mr. Story B. Ladd, of the Census Office, and we are indebted to Bulletin No. 242 for most interesting matter herewith presented.

The growth of the number of patents granted in the United States to citizens of foreign countries, is a striking feature, and shows the high esteem in which this country is held by the world at large as a field for the exploitation of invention. The per cent. of patents to foreign inventors has more than doubled during each period of twenty years since 1860.

The majority of these foreign patentees are citizens of the great manufacturing countries; four-fifths of them are from England, France, Germany, and Canada; the number from the latter country being largely augmented by reason of her proximity to the United States. The patents to foreign inventors, 1890-1900, were distributed as follows:

| Country. | Number of Patents. | Per Cent. |
|---|---|---|
| Canada | 3,135 | 14.0 |
| England | 7,436 | 32.0 |
| France | 2,163 | 9.0 |
| Germany | 5,788 | 25.0 |
| All other countries | 4,561 | 20.0 |
| Total to citizens of foreign countries | 23,083 | 100.0 |

This marked growth in the number of patents to aliens is explained by the very liberal features of our patent system. Foreigners stand here on an equal footing with citizens of this country, and they are neither sub-

jected to restrictions in the matter of annuities or taxes payable after the grant of a patent, nor required to work an invention in this country to maintain it in force, as is the case in most foreign countries.

Moreover, the thorough examination made by our Patent Office as to the novelty of an invention prior to the allowance of an application for a patent—an examination that includes not only the patents and literature of our own country bearing on the art or industry to which the invention relates, but the patents of all patent-granting countries and the technical literature of the world—and the care exercised in criticising the framing of the claims have come to be recognized as of great value in the case of inventions of merit, and hence the majority of foreign inventors patenting in this country take advantage of this feature of our patent system, and secure the action of the Patent Office on an application for a patent before perfecting their patents in their own and other foreign countries, taking due precaution to have their patents in the different countries so issued as to secure the maximum term in each, so far as possible. This practice holds now in the case of probably nine-tenths of the alien inventions patented in this country.

The working of an invention has never been required under our patent laws, though in most foreign countries, with the exception of Great Britain, an invention must be put into commercial use in the country within a specified period or the patent may be declared void. In the case of patents for fine chemicals and like products, which require a high order of technical knowledge and ability for their inception, and skilled workmen for their manufacture, the effect of this requirement, that the industry must be established within the country, has been most salutary in building up chemical industries within the home country, to some extent at the expense of other countries where the working of a patent is not obligatory. This shows most strongly in the case of carbon dyes and in the patents for chemicals of the class known as carbon compounds, which includes numerous pharmaceutical and medicinal compounds of recent origin, aldehydes, alcohols, phenols, ethers, etc., and many synthetic compounds, as vanillin, artificial musk, etc.

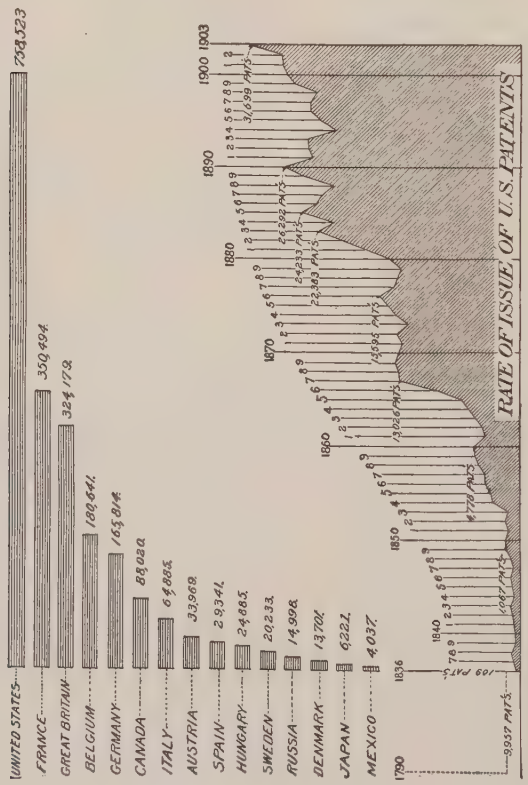
There are many extensive industries which are entirely the creation of patents, and can be readily differentiated from the great mass of manufactures; for example, certain industries based upon chemical inventions and discoveries, as oleomargarine, which now employs $3,023,646 of capital, and supplies products to the value of $12,499,812; glucose, which uses $41,011,345 of capital, and gives products to the value of $21,693,656; wood pulp, which, starting with the ground-wood pulp patent of Voulter, in 1858, and following with the soda fiber and sulphite fiber processes, is now the chief material employed in paper manufacture, with products aggregating $18,497,701; high explosives, which, starting with the nitroglycerin patent of Nobel, in 1865, now includes dynamite, the pyroxylin explosives, and smokeless powder, with products aggregating $11,233,396; while the electrical industries, which now touch all fields of industrial activity, power and transportation, lighting and heating, electrochemical processes, telegraphy and telephony, employ directly and indirectly capital extending into the billions, and are the creation of patents. The rubber industry was insignificant prior to the discovery by Charles Goodyear of the process of vulcanization, while now the products in the shape of rubber and elastic goods and rubber boots and shoes amount to $93,716,849. Bicycles and tricycles employ $29,783,659 of capital, with products valued at $31,915,908. Manufactured ice employs $38,204,054 of capital, with a return in products of $13,874,513.

Phonographs and graphophones, starting in 1877, now show the use of $3,348,282 of capital, and products to the value of $2,246,274. Photography, including the manufacture of materials and apparatus as well as the practice of the art—all the outcome of invention—is now represented by 7,706 establishments, with a combined capital of $18,711,339, and products to the value of $31,038,107. The manufacture of sewing machines employs $18,739,450 of capital, and supplies products to the value of $18,314,490. The manufacture of typewriters and supplies, within three decades, has become an industry that employs $8,400,431 of capital, and gives products to the value of $6,932,029. These are but examples of what may be considered as patent-created industries.

If we attempt to enumerate the industries which, existing prior to the

period of patent growth, have been revolutionized by inventions, a catalogue of all of the old industries is virtually required. The returns for the manufacture of agricultural implements for the present census show 715 establishments, with a capital of $157,707,951, giving employment to 46,852 wage-earners, who receive $2,450,880 in wages, and manufactured products to the value of $101,207,428; and, in the entire range of agricultural implements and machines now manufactured, every one, from hoe or spade to combined harvester and thrasher, has been, either in the implement or machine itself, or in the process of manufacture, the subject of a patented improvement which has produced a new or better article, or cheapened the cost of manufacture.

The great iron and steel industry as it exists to-day is the product of countless inventions which permeate every branch thereof, and include many revolutionizing inventions, as, for example, the Bessemer process. The blast furnaces, rolling mills and forges and bloomeries, reported at the present census comprise 668 establishments, with a capital of $573,391,663, employing 222,490 wage-earners, with $120,820,276 paid in wages, and supplying products to the value of $803,968 273. A prohibition of the use of the patented inventions of the last half




TOTAL NUMBER OF PATENTS TO DECEMBER 31, 1903.
(Foreign Patents for 1903 Estimated).

century would stop every one of these establishments.

The same may likewise be said of the textile industry, the manufactures of leather, of lumber, chemicals, etc., and the railway system in its entirety, from the rail to the top of the smoke-stack, and from the pilot to the rear train light or signal, is an aggregation of American inventions.

Without attempting to touch upon the industries which have been revolutionized or expanded by patents, the summaries which follow aim to show the growth of patents which have generally sprung from industries.

The closing decades of the nineteenth century have witnessed the most extraordinary development of manufactures and commerce known in our history. Industrial demand and invention go hand in hand. They act and react, being interdependent. Any change in industrial conditions creating a new demand is at once met by the invention of the means for supplying it, and through new inventions new industrial demands are every year being created. Thus through the process of evolution the industrial field is steadily expanding, and a study of the inventions for any decade will point out the lines of industrial growth for the succeeding decade.

The following figures give an idea of the development of American inventions during the past fifty-four years:

NUMBER OF PATENTS FOR INVENTIONS ISSUED DURING EACH CALENDAR YEAR, AND NUMBER OF LIVE PATENTS AT THE BEGINNING OF EACH CALENDAR YEAR.

| Year. | Number of Patents Issued During the Year. | Number of Live Patents. | Year. | Number of Patents Issued During the Year. | Number of Live Patents. |
|---|---|---|---|---|---|
| 1851 | 757 | 7,769 | 1878 | 12,345 | 168,011 |
| 1852 | 890 | 8,099 | 1879 | 12,133 | 177,737 |
| 1853 | 846 | 8,474 | 1880 | 12 926 | 186,408 |
| 1854 | 1,759 | 8,928 | 1881 | 15,548 | 195,325 |
| 1855 | 1,892 | 10,251 | 1882 | 18,135 | 206,043 |
| 1856 | 2,315 | 11,673 | 1883 | 21,196 | 218,041 |
| 1857 | 2,686 | 13,518 | 1884 | 19,147 | 230,360 |
| 1858 | 3,467 | 15,714 | 1885 | 23,331 | 237,204 |
| 1859 | 4,165 | 18,714 | 1886 | 21,797 | 247,991 |
| 1860 | 4,363 | 22,435 | 1887 | 20,429 | 256,831 |
| 1861 | 3,040 | 26,252 | 1888 | 19,585 | 265,103 |
| 1862 | 3,221 | 28,795 | 1889 | 23,360 | 273,001 |
| 1863 | 3,781 | 31,428 | 1890 | 25,322 | 284,161 |
| 1864 | 4,638 | 34,244 | 1891 | 22,328 | 297,867 |
| 1865 | 6,099 | 38,034 | 1892 | 22,661 | 307,965 |
| 1866 | 8,874 | 43,415 | 1893 | 22,768 | 317,335 |
| 1867 | 12,301 | 51,433 | 1894 | 19,875 | 325,931 |
| 1868 | 12,544 | 62,929 | 1895 | 20,883 | 332,886 |
| 1869 | 12,957 | 73,824 | 1896 | 21,867 | 341,424 |
| 1870 | 12,157 | 85,005 | 1897 | 22,098 | 351,158 |
| 1871 | 11,687 | 94,910 | 1898 | 20,404 | 360,330 |
| 1872 | 12,200 | 104,022 | 1899 | 23,296 | 365,186 |
| 1873 | 11,616 | 112,937 | 1900 | 24,660 | 370,347 |
| 1874 | 12,230 | 120,551 | 1901 | 25,558 | 373,811 |
| 1875 | 13,291 | 128,547 | 1902 | 27,136 | 380,222 |
| 1876 | 14,172 | 141,157 | 1903 | 31,046 | 393,276 |
| 1877 | 12.920 | 155,200 | 1904 | 30,267 | 403,958 |

The theory of the patent law is simple. The country is enriched by inventions. and offers for them a small premium; this premium is a seventeen years' monopoly of their fruit—no more, no less. Having purchased the invention for this insignificant price, the purchase is consummated by the publication in the patent records of the details of the invention. so that he who runs may read. The whole thing is a strictly business transaction, and

this character is emphasized by the fact that the inventor is required to pay for the clerical and expert labor required to put his invention into shape for issuing. His patent fees are designed to cover this expense, and do so, with a considerable margin to spare. Thus the people of the United States are perpetually being enriched by the work of inventors, at absolutely no cost to themselves.

The inventor does not work for love nor for glory alone, but in the hopes of a return for his labor. Glory, and love of his species, are elements actuating his work, and in many cases he invents because he cannot help himself, because his genius is a hard task master and keeps him at work. But none the less, the great incitement to invention is the hope of obtaining a valuable patent, and without this inducement inventions would be few and far between, and America would, without the patent system, be far in arrears of the rest of the world, instead of leading it, as it does to-day. The few pregnant sentences of the patent statutes, sentences the force of whose every word has been laboriously adjudicated by our highest tribunal, the Supreme Court of the United States, are responsible for America's most characteristic element of prosperity, the work of her inventors, to whom belongs the credit.

## DISTINGUISHED AMERICAN INVENTORS.

Benjamin Franklin; b. Boston, 1706; d. 1790; at 12, printer's apprentice, fond of useful reading; 27 to 40, teaches himself Latin, etc., makes various useful improvements; at 40, studies electricity; 1752, brings electricity from clouds by kite, and invents the lightning rod.

Eli Whitney, inventor of the cotton-gin; b. Westborough, Mass., 1765; d. 1825; went to Georgia 1792 as teacher; 1793, invents the cotton-gin, prior to which a full day's work of one person was to clean by hand one pound of cotton; one machine performs the labor of five thousand persons; 1800, founds Whitneyville, makes firearms, by the interchangeable system for the parts.

Robert Fulton; b. Little Britain, Pa., 1765; d. 1825; artist painter; invents steamboat 1793; invents submarine torpedoes 1797 to 1801; builds steamboat in France 1803; launches passenger boat Clermont at N. Y. 1807, and steams to Albany; 1812, builds steam ferryboats; 1814, builds first steam war vessel.

Jethro Wood, inventor of the modern cast-iron plough; b. White Creek, N. Y., 1774; d. 1834; patented the plough 1814; previously the plough was a stick of wood plated with iron; lawsuits against infringers consumed his means; Secretary Seward said: "No man has benefited the country pecuniarily more than Jethro Wood, and no man has been as inadequately rewarded."

Thomas Blanchard; b. 1788, Sutton, Mass.; d. 1864; invented tack machine 1806; builds successful steam carriage 1825; builds the stern-wheel boat for shallow waters, now in common use on Western rivers; 1843, patents the lathe for turning irregular forms, now in common use all over the world for turning lasts, spokes, axe-handles, gun-stocks, hat-blocks, tackle-blocks, etc.

Ross Winans, of Baltimore; b. 1798, N. J.; author of many inventions relating to railways; first patent, 1828; he designed and patented the pivoted, double truck, long passenger cars now in common use. His genius also assisted the development of railways in Russia.

Cyrus H. McCormick, inventor of harvesting machines; b. Walnut Grove, Va., 1809; in 1851 he exhibited his invention at the World's Fair, London, with practical success. The mowing of one acre was one man's day's work; a boy with a mowing machine now cuts 10 acres a day. Mr. McCormick's patents made him a millionaire.

Charles Goodyear, inventor and patentee of the simple mixture of rubber and sulphur, the basis of the present great rubber industries throughout the world; b. New Haven, Conn., 1800; in 1839, by the accidental mixture of a bit of rubber and sulphur on a red-hot stove, he discovered the process of vulcanization. The Goodyear patents proved immensely profitable.

Samuel F. B. Morse, inventor and patentee of electric telegraph; b. Charlestown, Mass., 1791; d. 1872; artist painter; exhibited first drawings of telegraph 1832; half-mile wire in operation 1835; caveat 1837; Congress appropriated $30,000 and in 1844 first telegraph line from Washington to Baltimore was opened; after long con-

tests the courts sustained his patents and he realized from them a large fortune.

Elias Howe, inventor of the modern sewing machine; b. Spencer, Mass., 1819; d. 1867; machinist; sewing machine patented 1846; from that time to 1854 his priority was contested and he suffered from poverty, when a decision of the courts in his favor brought him large royalties, and he realized several millions from his patent.

James B. Eads; b. 1820; author and constructor of the great steel bridge over the Mississippi at St. Louis, 1867, and the jetties below New Orleans, 1876. His remarkable energy was shown in 1861 when he built and delivered complete to the Government, all within sixty-five days, seven iron-plated steamers, 600 tons each; subsequently other steamers. Some of the most brilliant successes of the Union arms were due to his extraordinary rapidity in constructing these vessels.

Prof. Joseph Henry; b. Albany, N. Y., 1799; d. 1878; in 1828 invented the present form of the electro-magnet which laid the foundation for practically the entire electrical art and is probably the most important single contribution thereto. In 1831 he demonstrated the practicability of the electric current to effect mechanical movements and operate signals at a distant point, which was the beginning of the electro-magnetic telegraph; he devised a system of circuits and batteries, which contained the principle of the relay and local circuit, and also invented one of the earliest electro-magnetic engines. He made many scientific researches in electricity and general physics and left many valuable papers thereon. In 1826 he was a professor in the Albany Academy; was Professor of Natural Philosophy at the College of New Jersey in 1832, and in 1846 was chosen secretary of the Smithsonian Institution at Washington, where he remained until his death. Prof. Henry was probably the greatest of American physicists.

Dr. Alexander Graham Bell, the inventor of the telephone; b. 1847 at Edinburgh, Scotland, moved to Canada 1872 and afterward to Boston; here he became widely known as an instructor in phonetics and as an authority in teaching the deaf and dumb; in 1873 he began the study of the transmission of musical tones by telegraph; in 1876 he invented and patented the speaking telephone, which has become one of the marvels of the nineteenth century and one of the greatest commercial enterprises of the world; in 1880 the French Government awarded him the Volta prize of $10,000 and he has subsequently received the ribbon of the Legion of Honor from France and many honorary degrees, both at home and abroad; Dr. Bell still continues his scientific work at his home in Washington and has made valuable contributions to the phonograph and aerial navigation.

[Prof. Bell is now generally known as Dr. Bell, out of respect for his honorary degree.]

Thomas A. Edison; b. 1847, at Milan, Ohio; from a poor boy in a country village, with a limited education, he has become the most fertile inventor the world has ever known; his most important inventions are the phonograph in 1877, the incandescent electric lamp, 1878; the quadruplex telegraph, 1874-1878; the electric pen, 1876; magnetic ore separator, 1880, and the three-wire electric circuit, 1883; his first patent was an electric vote-recording machine, taken in 1869, since which time more than 700 patents have been granted him; early in life Edison started to run a newspaper, but his genius lay in the field of electricity, where as an expert telegrapher he began his great reputation; his numerous inventions have brought him great wealth; a fine villa in Llewellyn Park, at Orange, N. J., is his home, and his extensive laboratory near by is still the scene of his constant work; he is the world's most persevering inventor.

Captain John Ericsson; b. 1803 in Sweden; d. in New York, 1889; at 10 years of age, designed a sawmill and a pumping engine; made and patented many inventions in England in early life; in 1829 entered a locomotive in competition with Stephenson's Rocket; in 1836 patented in England his double-screw propeller and shortly after came to the United States and incorporated it in a steamer; in 1861, built for the United States Government the turret ironclad Monitor; was the inventor of the hot-air engine which bears his name; also a torpedo boat which was designed to discharge a torpedo by means of compressed air beneath the water; he was an indefatigable worker and made many other inventions; his diary, kept daily for 40 years, comprehended 14,000 pages.

Charles F. Brush; b. near Cleveland, Ohio, 1849; prominently identified with the development of the dynamo,

the arc light and the storage battery, in which fields he made many important inventions; in 1880 the Brush Company put its electric lights into New York City and has since extended its installations into most of the cities and towns of the United States; in 1881, at the Paris Electrical Exposition, he received the ribbon of the Legion of Honor.

George Westinghouse, Jr.; b. at Central Bridge, N. Y., 1846; while still a boy he modeled and built a steam engine; his first profitable invention was a railroad frog; his most notable inventions, however, were in railroad airbrakes, the first patents for which were taken out in 1872; the system now known by his name has grown to almost universal adoption and constitutes a great labor saving and life saving adjunct to railroad transportation; Mr. Westinghouse, whose home is at Pittsburg. was one of the earliest to develop and use natural gas from deep wells; in late years he has made and patented many inventions in electrical machinery for the development of power and light, and has commercially developed the same on a large scale.

Ottmar Mergenthaler; b. 1854, at Würtemberg, Germany; d. 1899; inventor of the linotype machine; his early training as a watch and clock maker well fitted him for the painstaking and complicated work of his life, which was to make a machine which would mold the type and set it up in one operation; in 1872 Mergenthaler came to Baltimore and entered a machine shop, in which he subsequently became a partner; the first linotype machine was built in 1886 and put to use in the composing room of the New York Tribune; to-day all large newspaper and publishing houses are equipped with great batteries of these machines, costing over $3,000 each, and each performing the work of five compositors.

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The first recorded patent granted by the United States Government bears date July 31, 1790, issued to Samuel Hopkins, for making pot and pearl ashes. Two other patents were granted in that year. In the following year, 1791, thirty-three patents were granted. Among them were six patents to James Rumsay and one to John Fitch for inventions relating to steam engines and steam vessels. For the single year of 1876 the number of patents and caveats applied for was almost 20,000.

## PROGRESS OF INVENTIONS.

Below is given in chronological order a list of important inventions beginning with the 16th century, with the title of the invention, the year it was made, the name of the inventor and his nativity:

| Inventions. | Date. | Inventor. | Nativity. |
|---|---|---|---|
| Discoveries of electrical phenomena | 1560 | William Gilbert | England |
| Won the title of "founder of the science of electricity." | 1603 | | |
| Screw printing-press | 1620 | | |
| Spirally grooved rifle barrel | 1620 | Blaew | Germany |
| Iron furnaces | 1621 | Koster | England |
| The use of steam | 1630 | Lord Dudley | England |
| The first authentic reference in English literature to the use of steam in the arts. | | David Ramseye | England |
| Bay Psalm Book, first book published in the Colonies | 1640 | | Mass. |
| Barometer | 1643 | Torricelli | Italy |
| Steam engine, atmospheric pressure | 1663 | Thomas Newcomen | England |
| Machine for generating electricity | 1681–6 | Otto von Guericke | Germany |
| First paper mill in America | 1690 | William Rittenhouse | Penna. |
| First steam engine with a piston | 1690 | Denys Papin | France |
| The manufacture of plate glass established | 1695 | | France |
| First to discover difference between electric conductors and insulators | 1696<br>1736 | Stephen Gray | England |
| The first practical application of the steam engine | 1702 | Thomas Savery | England |
| First newspaper in America, "Boston News Letter" | 1704 | John Campbell | Mass. |
| First to produce electric spark | 1708<br>1716 | Dr. J. Wall | England |

PROGRESS OF INVENTIONS—*Continued.*

| Inventions. | Date. | Inventor. | Nativity. |
|---|---|---|---|
| Thermometer | 1709 | Fahrenheit | Danzig |
| Electrometer, the well-known pith ball | 1718 to 1772 | John Cantor | England |
| The "Franklin" printing-press | 1725 | Benjamin Franklin | Utd. States |
| Electrical glass plate machine | 1727 to 1772 | Martin de Planta | France |
| Stereotyping | 1731 | William Ged | Scotland |
| First to discover that electricity is of two kinds | 1733–9 | Cisternay du Fay | France |
| Flying shuttle in weaving | 1733 | John Kay | England |
| Rotary 3-color printing-press (multi-color) | 1743 | Platt & Keen | England |
| Electric or Leyden Jar | 1745 | Kleist | Germany |
| Substitution of coke for coal in melting iron | 1750 | Abraham Darby | England |
| Lightning conductor | 1752 | Benjamin Franklin | Utd States |
| Spinning jenny | 1763 | James Hargreaves | England |
| Pianoforte, played in public in England in | 1767 | | England |
| Drawing rolls in a spinning machine | 1769 | Richard Arkwright | England |
| The introduction of the "Hollander" or beating engine for pulping rags in the manufacture of paper | 1773 | | |
| The mule spinner | 1774 | Samuel Crampton | England |
| Cut nails | 1775 | Jeremiah Wilkinson | Utd. States |
| Circular wood saw | 1777 | Miller | England |
| Embryo bicycle | 1779 | Branchard & Magurier | France |
| Steam engine, the basis of the modern engine | 1782 | James Watt | Scotland |
| Gas balloon | 1783 | J. E. & J. M. Montgolfier | France |
| Puddling iron | 1783–4 | Henry Cort | England |
| Plow, with cast-iron mold board, and wrought- and cast-iron shares | 1784 | James Small | Scotland |
| Power loom | 1785 | James Cartwright | England |
| First steamboat in the United States | 1786 | John Fitch | Utd. States |
| Steam road wagon (first automobile) | 1787 | Oliver Evans | Utd. States |
| Grain threshing machine | 1788 | Andrew Meikle | England |
| Hobby horse, forerunner of bicycle | 1790 | | England |
| Rotary steam power printing-press, the first idea of | 1790 | Wm. Nicholson | England |
| Wood planing machine | 1791 | Samuel Bentham | England |
| Gas first used as an illuminant | 1792 | Wm. Murdoch | England |
| Cotton gin | 1794 | Eli Whitney | Utd. States |
| Art of lithography | 1796 | Alois Senefelder | Germany |
| Machine for making continuous webs of paper | 1800 | Louis Robert | France |
| Electric battery discovered | 1800 | Volta | Italy |
| Steam coach | 1801 | Richard Trevithick | England |
| Wood mortising machine | 1801 | M. J. Brunel | England |
| Pattern loom | 1801 | M. J. Jacquard | France |
| First fire-proof safe | 1801 | Richard Scott | England |
| Steamboat on the Clyde, "Charlotte Dundas" | 1802 | William Symington | England |
| First photographic experiments | 1802 | Wedgwood & Davy | England |
| Planing machine | 1802 | J. Bramah | England |
| The application of steam to the loom | 1803 | William Horrocks | England |
| Steel pen | 1803 | Wise | England |
| Steam locomotive on rails | 1804 | Richard Trevithick | England |
| Application of twin-screw propellers in steam navigation | 1804 | John Stevens | Utd. States |
| Process of making malleable-iron castings | 1804 | Lucas | England |
| First life preserver | 1805 | John Edwards | England |
| Electro-plating | 1805 | Luigi Brugnatelli | Italy |
| Knitting machine, the latch needle in the | 1806 | Jeandeau | France |
| Steamboat navigation on the Hudson River | 1807 | Robert Fulton | Utd. States |
| Percussion or detonating compound | 1807 | A. J. Forsyth | Scotland |
| First street gas lighting in England | 1807 | F. A. Winsor | England |
| Band wood saw | 1808 | Newberry | England |
| Voltaic arc | 1808 | Sir Humphry Davy | England |
| First steamboat to make a trip to sea, the "Phœnix" | 1808 | John Stevens | Utd. States |
| Multi-wire telegraphy | 1809 | Sommering | Germany |
| Revolving cylinder printing-press | 1810 | Frederick Koenig | Germany |
| Breech-loading shotgun | 1811 | Thornton & Hall | Utd. States |
| Storage battery | 1812 | J. B. Ritter | Germany |
| Dry pile (prototype of dry battery) | 1812 | Zamboni | Italy |
| First practical steam rotary printing-press, paper printed on both sides | 1814 | Frederick Koenig | Germany |

PROGRESS OF INVENTIONS—*Continued.*

| Inventions. | Date. | Inventor. | Nativity. |
|---|---|---|---|
| First locomotive in United States | 1814 | George Stephenson | England |
| First circular wood saw made in this country | 1814 | Benjamin Cummings | Utd. States |
| Heliography | 1814 | Jos. N. Niepce | France |
| Kaleidoscope | 1814 | Sir David Brewster | England |
| Miners' safety lamp | 1815 | Sir Humphry Davy | England |
| Dry gas meter | 1815 | S. Clegg | England |
| Knitting machine | 1816 | Brunel. | England |
| "Draisine" bicycle | 1816 | Baron von Drais | Germany |
| "Columbian" press, elbowed pulling bar, number of impressions per hour, 50 | 1817 | George Clymer | Utd. States |
| Stethoscope | 1819 | Laënnec | France |
| Electro-magnetism discovered | 1819 | H. C. Oersted | Denmark |
| Lathe for turning irregular wood forms | 1819 | Thomas Blanchard | Utd. States |
| The theory of electro-dynamics first propounded | 1820 | Andre Ampère | France |
| Electroscope | 1820 | Bohenberg | Germany |
| The conversion of the electric current into mechanical motion | 1821 | Michael Faraday | England |
| Galvanometer | 1822 | Schweigger | Germany |
| Multi-color printing | 1822 | P. Force | Utd. States |
| Calculating machine | 1822 | Charles Babbage. | England |
| Discovery of thermo-electricity | 1823 | Prof. Seebeck | England |
| Liquefaction and solidification of gas | 1823 | Michael Faraday | England |
| Water gas, discovery of | 1823 | Ibbetson | England |
| Portland cement | 1825 | Joseph Aspdin | England |
| Electro-magnet | 1825 | Sturgeon | England |
| First passenger railway, opened between Stockton and Darlington, England | 1825 | | |
| Electrical spur wheel | 1826 | Barlow | England |
| First railroad in United States, near Quincy, Mass. | 1826 | | |
| The law of galvanic circuits formulated | 1827 | George S. Ohm | Germany |
| Friction matches | 1827 | John Walker | Utd. States |
| The reduction of aluminum | 1827 | Friedrich Wohler | Germany |
| Law of electrical resistance | 1827 | George S. Ohm | Germany |
| Improved rotary printing-press, London Times, 5,000 impressions per hour | 1827 | Cowper & Applegarth | England |
| Hot air blast for iron furnaces | 1828 | J. B. Neilson | Scotland |
| Wood planing machine | 1828 | William Woodworth | Utd. States |
| Spool electro-magnet | 1828 | Joseph Henry | Utd. States |
| Tubular locomotive boiler | 1828 | Séquin | France |
| Spinning ring frame | 1828 | John Thorp | England |
| The "Washington" printing-press, lever motion and knuckle joint for a screw, number of impressions per hour, 200 | 1829 | Samuel Rust | Utd. States |
| First steam locomotive in United States, "Stourbridge Lion" | 1829 | | |
| Double fluid galvanic battery | 1829 | A. C. Becquerel | France |
| First portable steam fire engine | 1830 | Brathwaite & Ericsson | England |
| Magneto-electric induction | 1831 | Michael Faraday | England |
| Chloroform | 1831 | G. J. Guthrie | Scotland |
| First conception of electric telegraph | 1832 | Prof. S. F. B. Morse | Utd. States |
| First magneto-electric machines | 1832 | Saxton | Utd. States |
| Rotary electric motor | 1832 | Wm. Sturgeon | England |
| Chloral-hydrate | 1832 | Justus von Liebig | Germany |
| Locomotive, "Old Ironsides," built | 1832 | M. W. Baldwin | Utd. States |
| Link-motion for locomotives | 1832 | Sir Henry James | England |
| Adoption of steam whistle for locomotives | 1833 | George Stephenson | England |
| Reciprocating saw-tooth cutter within double guard fingers for reapers | 1833 | Obed Hussey | Utd. States |
| "McCormick" reaper | 1834 | Cyrus H. McCormick | Utd. States |
| Rotary electric motor | 1834 | M. H. Jacobi | Russia |
| Carbolic acid discovered | 1834 | Runge | Germany |
| Horseshoe machine | 1835 | H. Burden | Utd. States |
| Constant electric battery | 1836 | J. P. Daniell | England |
| Acetylene gas discovered | 1836 | Edmund Davy | England |
| The revolver; a device "for combining a number of long barrels so as to rotate upon a spindle by the act of cocking the hammer" | 1836 | Samuel Colt | Utd. States. |
| The screw applied to steam navigation | 1836 to 1841 | John Ericsson | Utd. States |
| The galvanizing of iron | 1837 | Henry Craufurd | England |

PROGRESS OF INVENTIONS—*Continued.*

| Inventions. | Date. | Inventor. | Nativity. |
|---|---|---|---|
| Indicator-telegraph | 1837 | Cooke & Wheatstone | England |
| Photographic carbon printing | 1838 | Mungo Ponton | France |
| Babbitt metal | 1839 | Isaac Babbitt | Utd. States |
| Vulcanization of rubber | 1839 | Charles Goodyear | Utd. States |
| The first boat electrically propelled | 1839 | Jacobi | Germany |
| Daguerreotype. (First to produce a direct photographic positive in the camera by means of highly polished silver surfaced plate exposed to the vapors of iodine and subsequent development with mercury vapor.) | 1839 | Louis Daguerre | France |
| Making photo-prints from paper negatives. (First production of positive proofs from negatives.) | 1839 | Fox Talbot | England |
| Photographic portraits (Daguerreotype process.) | 1839 | Profs. Draper & Morse | Utd. States |
| First incandescent electric lamp | 1840 | Grove | England |
| Celestial photography | 1840 | Draper | Utd. States |
| Artesian well | 1840 | | Paris |
| Pneumatic caissons | 1841 | M Triger | France |
| Pianoforte automatically played | 1842 | M. Seytre | France |
| Water gas, utilization of | 1842 | Selligne | France |
| Steam hammer | 1842 | James Nasmyth | Scotland |
| Typewriting machine | 1843 | Charles Thurber | Utd. States |
| First telegram sent | 1844 | Prof. S. F B. Morse | Utd. States |
| The use of nitrous oxide gas as an anæsthetic | 1844 | Dr. Horace Wells | Utd. States |
| The electric arc light (gas retort carbon in a vacuum) | 1844 | Léon Foucault | France |
| First telegraphic message, Washington, Baltimore | 1844 | Prof. S. F. B. Morse | Utd. States |
| Automatic adjustment of electric arc light carbons | 1845 | Thomas Wright | England |
| Double cylinder printing-press | 1845 | R. Hoe & Co. | Utd. States |
| Pneumatic tire | 1845 | R. W. Thompson | England |
| Sewing machine | 1846 | Elias Howe | Utd. States |
| Printing telegraph | 1846 | House | Utd. States |
| Suez canal started | 1846 | De Lesseps | France |
| Ether as an anæsthetic | 1846 | Dr. Morton. | Utd. States |
| Electric cautery | 1846 | Crusell | Russia |
| Artificial limbs | 1846 | | |
| Gun cotton | 1846 | Schönbein | Germany |
| First pianoforte keyboard player | 1846 | Debain | France |
| Chloroform in surgery | 1847 | Dr. Simpson | Scotland |
| Nitro-glycerine | 1847 | Sobrero | |
| Time-lock | 1847 | Savage | Utd. States |
| Hoe's lightning press, capable of printing 20,000 impressions per hour | 1847 | Richard M. Hoe | Utd. States |
| Match-making machinery | 1848 | A. L. Dennison | Utd. States |
| Breech gun-lock, interrupted thread | 1849 | Chambers | Utd. States |
| Magazine gun | 1849 | Walter Hunt. | Utd. States |
| Steam pressure gauge | 1849 | Bourdon | France |
| Lenticular stereoscope | 1849 | Sir David Brewster | England |
| Latch needle for knitting machine | 1849 | J. T. Hibbert | Utd. States |
| "Corliss" engine | 1849 | G. H. Corliss | Utd. States |
| Printing-press, curved plates secured to a rotating cylinder | 1849 | Jacob Worms | France |
| Mercerized cotton | 1850 | John Mercer | England |
| Collodion process in photography | 1850 | Scott Archer | England |
| American machine-made watches | 1850 | | Utd. States |
| Electric locomotive | 1851 | Dr Page | Utd. States |
| Self-raker for harvesters | 1851 | W. H. Seymour | Utd. States |
| Breech-loading rifle | 1851 | Maynard | Utd. States |
| Icemaking machine | 1851 | J. Gorrie | Utd. States |
| Ophthalmoscope | 1851 | Helmholtz | Germany |
| The Ruhmkorff coil | 1851 | Ruhmkorff | Germany |
| Fire-alarm telegraph | 1852 | Channing & Farmer | Utd. States |
| Reticulated screen for half-tone photographic printing | 1852 | Fox Talbot | England |
| Soda process of making pulp from wood | 1853 | Watt & Burgess | Utd. States |
| Laws of magneto-electric induction | 1853 | Michael Faraday | England |
| Laws of electro-statics | 1853 | Michael Faraday | England |

PROGRESS OF INVENTIONS—*Continued.*

| Inventions. | Date. | Inventor. | Nativity. |
|---|---|---|---|
| Electrolysis | 1853 | Michael Faraday | England |
| Duplex telegraph | 1853 | Gintl | Austria |
| Photographic roll films | 1854 | Melhuish | England |
| Diamond rock drill | 1854 | Herman | Utd. States |
| Four-motion feed for sewing machines | 1854 | A. B. Wilson | Utd. States |
| Magazine firearm | 1854 | Smith & Wesson | Utd. States |
| Fat decomposed by water or steam at high temperature, since largely used in soap making | 1854 | R. A. Tilghman | Utd. States |
| Safety matches | 1855 | Lundstrom | Sweden |
| Iron-clad floating batteries first used in Crimean war | 1855 | | |
| Cocaine | 1855 | Gaedeke | Germany |
| Process of making steel, blowing air through molten pig iron | 1855 | Sir Henry Bessemer | England |
| Dryplate photography | 1855 | Dr. J. M. Taupenot | |
| Bicycle | 1855 | Ernst Michaux | France |
| Sleeping car | 1856 | Woodruff | Utd. States |
| Aniline dyes | 1856 | Perkins | England |
| Printing machine for the blind (contains elements of the present typewriting machine) | 1856 | Alfred E. Beach | Utd. States |
| Regenerative furnace | 1856 | Wm. Siemens | England |
| Refining engine in paper pulp making | 1856 | T. Kingsland | Utd. States |
| Coal-oil first sold in the United States | 1857 | Messrs. Stout & Hand | Utd. States |
| First sea-going iron-clad war vessel, the "Glorie" | 1857 | | France |
| Ground wood pulp | 1858 | Henry Voelter | Germany |
| Inclined elevator and platform in the reaper | 1858 | J. S Marsh | Utd. States |
| Cable car | 1858 | E. A. Gardner | Utd. States |
| Breech-loading ordnance | 1858 | Wright & Gould | Utd. States |
| Feed injector for boilers | 1858 | Giffard | France |
| First Atlantic cable | 1858 | Cyrus Field | Utd. States |
| Great Eastern launched | 1859 | | |
| Storage or secondary battery | 1860 | Gaston Planté | France |
| Singing telephone | 1860 | Philip Reis | Germany |
| Ammonia absorption ice machine | 1860 | F P. E. Carré | France |
| Improved stereotyping process | 1861 | Charles Craske | Utd. States |
| Shoe-sewing machine | 1861 | George McKay | Utd. States |
| Driven well, a tube with a pointed perforated end driven into the ground | 1861 | Col. N. W. Green | Utd. States |
| Passenger elevator | 1861 | E. G. Otis | Utd. States |
| Barbed-wire fence introduced | 1861 | | Utd. States |
| Calcium carbide produced | 1862 | Frederich Woehler | Germany |
| Revolving turret for floating battery | 1862 | Theodore Timby | Utd. States |
| First iron-clad steam battery, "Monitor" | 1862 | John Ericsson | Utd. States |
| Gatling gun | 1862 | Dr. R. J. Gatling | Utd. States |
| Smokeless gunpowder | 1863 | J. F. E. Schultze | Prussia |
| Pneumatic pianoforte player (regarded as first to strike keys by pneumatic pockets) | 1863 | M. Fourneaux | France |
| Explosive gelatine | 1864 | A. Nobel | France |
| Rubber dental plate | 1864 | J. A. Cummings | Utd. States |
| Automatic grain-binding device | 1864 | Jacob Behel | Utd. States |
| Process of making fine steel | 1865 | Martin | Utd. States |
| Antiseptic surgery | 1865 | Sir Joseph Lister | England |
| Web-feeding printing-press | 1865 | William Bullock | Utd. States |
| Automatic shell ejector for revolver | 1865 | W. C. Dodge | Utd. States |
| Open-hearth steel process | 1866 | Siemens-Martin | England |
| Compressed air rock drill | 1866 | C. Burleigh. | Utd. States |
| Torpedo | 1866 | Whitehead | Utd. States |
| Dynamo electric machine | 1866 | Wilde | England |
| Sulphite process for making paper pulp from wood | 1867 | Tilghman | Utd. States |
| Dynamo electric machine | 1866 | Siemens | Germany |
| Disappearing gun carriage | 1868 | Moncrief | England |
| First practical typewriting machine | 1868 | C. L. Sholes | Utd. States |
| Dynamite | 1868 | A. Nobel | France |
| Oleomargarine | 1868 | H. Mege | France |
| Water heater for steam fire engine | 1868 | W. A. Brickell | Utd. States |
| Sulky plow | 1868 | B. Slusser | Utd. States |
| Railway air-brake | 1869 | George Westinghouse | Utd. States |
| Tunnel shield (operated by hydraulic power) | 1869 | Alfred E. Beach | Utd. States |
| A curved spring tooth harrow | 1869 | David L. Garver | Utd. States |

PROGRESS OF INVENTIONS—*Continued.*

| Inventions. | Date. | Inventor. | Nativity. |
|---|---|---|---|
| Dynamo-electric machine | 1870 | Gramme | France |
| Celluloid | 1870 | J. W. & Isaac Hyatt | Utd. States |
| Rebounding gun-lock | 1870 | L. Hailer | Utd. States |
| The Goodyear welt shoe-sewing machine | 1871 | Goodyear | Utd. States |
| Photographic gelatino-bromide emulsion (basis of present rapid photography) | 1871 | R. L. Maddox | England |
| Continuous web printing-press | 1871 | Hoe & Tucker | Utd. States |
| Grain binder | 1871 | S. D. Locke | Utd. States |
| Compressed air rock drill | 1871 | S. Ingersoll | Utd. States |
| Positive motion weaving loom | 1872 | J. Lyall | Utd. States |
| Theory that light is an electric phenomenon | 1872 | Clerk Maxwell | England |
| Automatic air brake | 1872 | George Westinghouse | Utd. States |
| Automatic car coupler | 1873 | E. H. Janney | Utd. States |
| The photographic platinotype process. (Prints by this process are permanent.) | 1873 | Willis | England |
| Quadruplex telegraph | 1873 | T. A. Edison | Utd. States |
| Twine binder for harvesters | 1873 | M. L. Gorham | Utd. States |
| Gelatino-bromide photographic emulsion (sensitiveness to light greatly increased by the application of heat) | 1873 | Charles Bennett | England |
| Self-binding reaper | 1873 | Locke & Wood | Utd. States |
| Barbed-wire machine | 1874 | Glidden & Vaughan | Utd. States |
| Siphon recorder for submarine telegraphs | 1874 | Sir William Thompson | England |
| Store cash carrier | 1875 | D. Brown | Utd. States |
| Illuminating water gas | 1875 | T. S. C. Lowe | Utd. States |
| Roller flour mills | 1875 | F. Wegmann | Utd. States |
| Middlings purifier for flour | 1875 | Geo. T. Smith | Utd. States |
| Ice-making machine | 1875 | R. P. Pictet | Switzerland |
| Speaking telephone | 1876 | Alex. G. Bell | Utd. States |
| Electric candle. (The first step towards the division of the electric current for lighting.) | 1876 | Paul Jablochkoff | Russia |
| Continuous machine for making tobacco cigarettes | 1876 | Russell | Utd. States |
| Steam feed saw mills | 1876 | D. C. Prescott | Utd. States |
| The first Portland cement plant in U. S. | 1876 | | Coplay, Pa. |
| Phonograph | 1877 | T. A. Edison | Utd. States |
| Gas engine | 1877 | N. A. Otto | Utd. States |
| Carbon microphone | 1877 | T. A. Edison | Utd. States |
| Telephone transmitter of variable resistance | 1877 | Emil Berliner | Utd. States |
| Carbon filament for electric lamp. (Beginning of the incandescent vacuum electric light.) | 1878 | T. A. Edison | Utd. States |
| Rotary disk cultivator | 1878 | Mallon | Utd. States |
| Decided advance in the "expression" of self-playing pianofortes | 1878 | Gally | Utd. States |
| Automatic grain binder | 1879 | J. F. Appleby | Utd. States |
| Cathode rays discovered | 1879 | Sir Wm. Crookes | England |
| Electric railway | 1879 | Siemens | Germany |
| Steam plow | 1879 | W. Foy | Utd. States |
| Magazine rifle | 1879 | Lee | Utd. States |
| "Blake" telephone transmitter | 1880 | Blake | Utd. States |
| Hammerless gun | 1880 | Greener | Utd. States |
| Storage battery or accumulator | 1880 | Camille A. Faure | France |
| Typhoid bacillus isolated | 1880 | Eberth & Koch | Germany |
| Pneumonia bacillus isolated | 1880 | Sternberg | Utd. States |
| Button-hole machine | 1881 | Reece | Utd. States |
| Improvement in "expression" of self-playing pianofortes | 1882 | Schmaele | Utd. States |
| Hand photographic camera for plates | 1881 | Wm. Schmid | Utd. States |
| Tuberculosis bacillus isolated | 1882 | Robert Koch | Germany |
| Hydrophobia bacillus isolated | 1882 | Louis Pasteur | France |
| Cholera bacillus isolated | 1884 | Robert Koch | Germany |
| Diphtheria bacillus isolated | 1884 | Loeffler | Germany |
| Lockjaw bacillus isolated | 1884 | Nicolaier | France |
| Antipyrene | 1884 | Kuno | Utd. States |
| Linotype machine | 1884 | Ottmar Mergenthaler | Germany |
| The rear-driven chain safety bicycle | 1884 | George W. Marble | Utd. States |
| Chrome tanning of leather | 1884 | Schultz | Utd. States |
| Process of reducing aluminum | 1885 | Cowles | England |
| Gas burner | 1885 | Carl Welsbach | Germany |

PROGRESS OF INVENTIONS—*Continued.*

| Inventions. | Date. | Inventor. | Nativity. |
|---|---|---|---|
| Hydraulic dredge | 1885 | Bowers | Utd. States |
| First electric railway in United States, Hampden and Baltimore, Md | 1885 | | |
| Contact device for overhead electric trolley | 1885 | C. J. Van Depoele | Utd. States |
| Graphophone | 1886 | Bell & Tainter | Utd. States |
| Electric welding | 1886 | Elihu Thompson | Utd. States |
| Combined harvester and thresher | 1886 | Matteson | Utd. States |
| Band wood saw | 1887 | D. C. Prescott | Utd. States |
| Cyanide process of obtaining gold and silver | 1887 | McArthur & Forrest | Utd. States |
| System of polyphase electric currents | 1887 | Nicola Tesla | Utd. States |
| Incandescent gas light | 1887 | Carl A. Von Welsbach | Austria |
| (The formation of a cone-shaped interwoven mantle of thread coated with a refractory rare earth and rendering the same incandescent by the heat rays of a Bunsen gas burner regardless of how the gas is produced.) | | | |
| Process of annealing armor plate | 1888 | Harvey | Utd. States |
| "Kodak" snap-shot camera | 1888 | Eastman & Walker | Utd. States |
| (Constructed to use a continuous sensitized ribbon film.) | | | |
| Process of making artificial silk | 1888 | H. DeChardonnet | France |
| Hertzian waves or electric-wave radiation | 1888 | Heinrich Hertz | Germany |
| First rotary cement kilns in U. S | 1889 | | Coplay, Pa. |
| Nickel steel | 1889 | Schneider | Utd. States |
| Process for making aluminum | 1889 | Chas. M. Hall | Utd. States |
| Electric plow | 1890 | W. Stephens | Utd. States |
| Improved linotype machine | 1890 | Ottmar Mergenthaler | Germany |
| Bicycles equipped with pneumatic tires | 1890 | | |
| Krag-Jörgensen magazine rifle | 1890 | Krag-Jörgensen | Utd. States |
| "Coherer" for receiving electric waves | 1891 | Edouard Branly | England |
| Rotary steam turbine | 1891 | C. A. Parsons | England |
| Cement-lined paper-pulp digester | 1891 | G. F. Russell | Utd. States |
| Round bale cotton press | 1891 | Brown | Utd. States |
| Microphone | 1891 | Emile Berliner | Utd. States |
| Power loom | 1891 | Northrup | Utd. States |
| Commercial application of formic-aldehyde | 1892 | J. J. A. Trillat | France |
| Shoe-last lathe, for different lengths | 1893 | Kimball | Utd. States |
| Kinetoscope | 1893 | T. A. Edison | Utd. States |
| Process for making carborundum | 1893 | E. G. Acheson | Utd. States |
| Calcium carbide produced in electric furnace | 1893 | Thos. L. Willson | Utd. States |
| Process for liquefying air | 1895 | Carl Linde | Germany |
| Electric locomotive, B. & O. Bell Tunnel | 1895 | | Utd. States |
| X-rays | 1895 | Prof. W. C. Roentgen | Germany |
| Acetylene gas from calcium carbide | 1895 | Thomas L. Willson | Utd. States |
| System of wireless telegraphy | 1896 | G. Marconi | Italy |
| Foundation laid of science of radio-activity, i.e., emanation of penetrating rays from luminescent bodies | 1896 | Henri Becquerel | France |
| Use of ultra-violet rays in treating diseases | 1896 | Niels R. Finsen | Denmark |
| Nernst electric light | 1897 | Walter Nernst | Germany |
| (Method of rendering a clay compound capable of conducting electricity and thence becoming brilliantly incandescent without a vacuum.) | | | |
| Mercury vapor electric light | 1900 | Peter Cooper Hewitt | Utd. States |
| (An artificial light composed strictly of the ultra-blue violet rays of the spectrum obtained by passing an electric current through a partial vacuum tube filled with mercury vapor, the latter acting as a conductor. Possesses remarkable actinic power for photographic purposes.) | | | |
| Air-ship | 1901 | M. Santos-Dumont | France |
| Automobile mower | 1901 | Deering Harvester Co | Utd. States |
| The first passenger steam turbine ship, "Edward VII." | 1901 | Denny & Brothers | England |
| The first oil-burning steamship built in the United States, "Nevada" | 1902 | | |
| English Pacific cable, Canada-Australia | 1902 | | |
| American Pacific cable | 1903 | | Utd. States |
| Berlin-Zossen Road, 130½ miles an hour | 1903 | | Germany |

—*Encyclopedia Americana.*

## GENERAL INFORMATION REGARDING PATENTS.

WHAT IS A PATENT?—The term *patent* or *letters patent* is derived from *litterae patentes*, signifying that which is open or disclosed in contradistinction to *lettre de cache*, that which is sealed or secret. This term is the keynote of the whole principle upon which the patent system is built up, namely, disclosure. The disclosure must be honest, absolute and unreserved. The penalty for mental crookedness or for ignorance in giving out fully and freely the nature of the invention is severe and direct and is nothing less than forfeiture of the patent itself. The reason for this is perfectly logical and arises from the very meaning, spirit and nature of the relationship existing between the patentee and the government. The term of a patent is 17 years. During this term of 17 years the patentee obtains a monopoly under which he secures exclusive right of manufacture, use and sale. The patent itself, however, is in the nature of a contract between the patentee and the government, presumably for their mutual benefit. The government grants to the inventor the exclusive right of manufacture and sale for 17 years on condition that the inventor shall disclose fully the nature of his invention or discovery, and shall allow the public the unrestricted use of the invention after this term has expired. If he fail in making full disclosure, he has not lived up to the terms of the implied contract and the patent thereby becomes null and void. It sometimes happens that an inventor discloses freely part of the invention, but cunningly conceals some essential step in the process, but if the case is tested within the courts and the real facts are brought to light, the patent will be declared invalid. At the end of the term of 17 years the patent becomes public property, and the article may be freely manufactured by any one. It can never thereafter, as in so many cases in the Middle Ages, become a lost art.

WHO MAY OBTAIN A PATENT?—In order to secure a valid patent, the applicant must declare upon oath that he believes himself to be the true, original and first inventor or discoverer of the art, machine, manufacture, composition or improvement for which he solicits a patent; that he does not know and does not believe that the same was ever before known or used; and that the invention has not been in public use or on sale in the United States for more than two years before the application was filed, and that the invention has not been described in any printed publication for more than two years prior to the filing of the application. Any one who can subscribe to the above conditions may apply for a patent, irrespective of race, color, age, or nationality. Minors and women and even convicts may apply for patents under our law. The rights even of a dead man in an invention are not lost, for an application may be filed in his name by his executor or administrator, and the rights of his heirs thereby safeguarded. The patent in this case would issue to the executor or administrator and would become subject to the administration of the estate like any other property left by the deceased. Even the rights of an insane person may not be lost, as the application may be filed by his legal guardian. If foreign patents for the same invention have been previously issued, having been filed more than 12 months before the filing of the United States application, the patent would be refused. The applicant must state his nationality. It often happens that two or more individuals have jointly worked upon the invention, and in this case the several inventors should jointly apply for the patent. Should they not so apply, the patent when issued would be invalid. If they are merely partners, however, and not co-inventors, they should not apply jointly for a patent, as the inventor alone is entitled to file the application. He may, however, assign a share in the patent to his partner, coupled with the request that the patent should issue to them jointly. It is of the greatest importance that these distinctions should be clearly understood; otherwise, the patent may be rendered invalid.

WHAT MAY BE PATENTED?—Any *new and useful* art, machine, manufacture or composition of matter, or any new and useful improvements thereon. The thing invented must be *new and useful*. These are conditions precedent to the granting of a patent. Of these two conditions by far the more important is the former, and it is concerning the interpretation of this word "*new*" and its bearing upon the invention that the principal work and labor involved in passing an application safely through the Patent Office is involved. When the invention has been worked

out by the inventor and he is prepared to file his application, his attorney prepares the necessary papers, as provided for by law, namely: An Oath, a Petition, a Specification consisting of a description of the invention and concluding with claims which specifically set forth what the inventor claims to be the novel features of the invention, and drawings which are prepared and filed with the case, and in due course the application is ready for examination in the Patent Office. The question of whether the invention is *new* is then considered, and the burden of proof that the invention is not new rests upon the Patent Office. The examination consists in searching through the files of the Patent Office among the patents that have been already issued, and through such literature as may bear upon the subject. If any reference is discovered that anticipates the invention, as defined by the claims of the specification, the applicant is informed of the fact, and he is allowed to amend his papers and narrow the claims so as to avoid the prior patents, if possible. If his attorney considers the position of the Patent Office untenable, he may present arguments to show wherein he believes that the inventor is entitled to a patent. It is thus seen that the question of whether an invention is new is one of fact, and one of the greatest importance, and upon the showing that the inventor is able to make during the prosecution of the case, depends largely the future success of the patent. The evidence adduced in proving that the invention is not new must be tangible and accessible. A patent would not be refused or overturned on a mere mental concept. There must be some evidence of a substantial character that serves to show that the earlier idea was reduced to practice or at least that there was such a description or drawing made, as would be sufficient for one skilled in the art to reduce the invention to practice. If it has not been actually reduced to practice, it must be a concrete not an abstract idea.

It is essential that the application for a patent should be filed before the invention has been in public use or on sale for a period of two years. If the inventor has publicly used or sold his invention for a period of two years, it becomes public property and he cannot regain the right to obtain a patent. He may, however, make models and experiment with his invention for a much longer period, provided he does not disclose his invention to the public or put it into actual use or on sale for a period of two years. The word "useful" is not one which usually gives either the Patent Office or the inventor a great deal of trouble, as any degree of utility, however insignificant, will serve to entitle the inventor to a patent. It has often happened that an invention which appears, at the time the patent is applied for, to have no special utility, in later years, owing to new discoveries or improvements in the arts, is found to possess the greatest merit and value. Unless an invention is positively meretricious, therefore, it is difficult to assume that it either has no utility or never will have any. Patents are granted for "any new and useful art, machine, manufacture or composition of matter, or any improvement thereon." It is seen from the terms of the statute that almost any creature of the inventive faculty of man becomes a proper subject for a patent. The exceptions are very few. Patents will not be granted, for example, for any invention that offends the law of nature. Under this category may be mentioned perpetual motion machines. In case an application of this character is presented, the Commissioner politely informs the applicant that the matter cannot be considered until a working model demonstrating the principle of the invention has been deposited in the Patent Office. Inventions of an immoral nature will not be considered. Medicines and specifics are not now proper subjects for letters patent, unless some important new discovery is involved.

PATENTED ARTICLES MUST BE MARKED.—Articles manufactured and sold under a patent must be so marked that the public shall have notice that the article is a patented one. This notice consists of the word "Patented," together with the date when the patent was issued or the Serial Number of the patent. Damages in an infringement suit cannot be recovered unless the defendant has received such notice that the article is patented. The term of a United States patent is 17 years. This term cannot be extended except by special Act of Congress. It is many years since a bill seeking an extension of the term of a patent has been passed by Congress.

APPEALS.—If an application for a patent has been rejected, the applicant may appeal from the Primary Examin-

er to the Board of Examiners-in-Chief. He may further carry the appeal to the Commissioner of Patents, and in case he is not satisfied with the latter decision, he may carry the appeal finally to the Court of Appeals of the District of Columbia.

INTERFERENCE.—If two or more individuals shall have invented the same thing at or about the same time, interference proceedings may be instituted to determine which applicant is the original or first inventor. Interference proceedings are instituted between applicants whose applications are pending or between a pending application and a patent already issued, provided the latter patent has not been issued for more than two years prior to the filing of the conflicting application. The proceedings are conducted before the Examiner of Interferences. Appeal may be taken from the Examiner of Interferences to the Board of Examiners-in-Chief, and from the Board of Examiners-in-Chief to the Commissioner, and thence to the Court of Appeals of the District of Columbia. Not all the claims for a patent are necessarily involved, only such as cover the particular feature of the invention which is declared to be in interference. The unsuccessful applicant by eliminating the claims or claim in controversy may procure allowance of the other claims not objected to, and have the patent issued. In determining the question of priority of invention, witnesses are examined and the proceedings are conducted much in the same manner as in a suit at law. The first step in the proceeding consists in filing with the Commissioner a Preliminary Statement made under oath, giving the date at which the invention was first conceived and reduced to some tangible form, such as the making of drawings, the construction of a model, or the disclosing of the invention to another. The object of the subsequent examination and cross-examination is to substantiate the date of invention as claimed by the applicants respectively, and to establish the priority of invention.

INFRINGEMENT.—In case of an action for the infringement of a patent, the importance of the question of novelty appears from the special pleadings which the defendant may enter, which are as follows:

1. That for the purpose of deceiving the public the description and specification filed by the patentee in the Patent Office was made to contain less than the whole truth relative to his invention or discovery, or more than is necessary to produce the desired effect; or,

2. That he had surreptitiously or unjustly obtained the patent for that which was in fact invented by another, who was using reasonable diligence in adapting and perfecting the same; or,

3. That it had been patented or described in some printed publication prior to his supposed invention or discovery thereof; or,

4. That he was not the original and first inventor or discoverer of any material and substantial part of the thing patented; or,

5. That it has been in public use or on sale in this country for more than two years before his application for a patent, or had been abandoned to the public.

Damages for infringement of a patent may be recovered by action on the case in the name of the patentee or his assignee. The courts having jurisdiction over such cases have the power (1) to grant injunctions against the violation of any right secured by the patent; (2) to allow the recovery of damages sustained by the complainant through such infringement. In such a case the defendant is compelled to furnish an accounting showing the amount of the articles manufactured and sold and the profits derived from such sale.

DESIGN PATENTS.—Design patents are issued for any new or original design, whether it be a work of art, statue, bas-relief, design for prints or fabrics, or for any new design or shape or ornament in any article of manufacture. The scope of the design patent was formerly very broad, but recent decisions and enactments have greatly restricted its availability and a design patent cannot now be obtained unless it possesses some inherent artistic quality. Mere utility is not sufficient to entitle a new design to letters patent. The terms of design patents are 3 1-2, 7 or 14 years.

CAVEATS.—Any one who has made a new invention or discovery, which is not yet completed or perfected, may file in the Patent Office a caveat, describing his invention, said caveat serving as notice to the Patent Office that the caveator is in possession of a certain invention partly developed, for which later he proposes to file an application for a patent. The caveat is filed by the Commission in the secret archives of the Patent Office, and is

operative for a term of one year. The term may be prolonged from year to year by the payment of a small fee. The caveat should not be confounded with a patent, for it gives the inventor no real protection or monopoly. It simply entitles him to notice in case another inventor files an application for the same invention. In this event the caveator is entitled to three months' grace within which to file his patent application, whereupon an interference will be declared between the two inventions.

ASSIGNMENTS.—A patent or any interest therein may be sold or assigned like any other piece of property. An inventor may sell or assign his interest or a part interest in his invention, either before the application is filed or while the application is still pending. Under these circumstances the patent may be issued to the assignee or to the inventor and assignee jointly. The patent, if already issued, may be assigned by the owner whether he be the inventor or assignee. The conveyance is effected by an instrument in writing stating the conditions under which the patent is assigned, and the assignment should be recorded in the Patent Office.—Enc. Americana.

## ABSTRACTS OF DECISIONS.

Where an inventor has completed his invention, if he neither applies for a patent nor puts it to practical use, a subsequent inventor who promptly applies is entitled to the patent, and the first one is deemed to have abandoned his rights. Pattee v. Russell, 3 O. G., 181; Ex parte Carre, 5 O. G., 30; Johnson v. Root, 1 Fisher, 351.

As between two rival inventors, the test of priority is the diligence of the one first to conceive it. If he has been diligent in perfecting it, he is entitled to receive the patent. If he has been negligent, the patent is awarded to his opponent. Robinson on Patents, Sec. 375.

The construction and use in public of a working machine, whether the inventor has or has not abandoned it, excludes the grant of a patent to a subsequent inventor. An abandonment in such case inures to the benefit of the public and not to the benefit of a subsequent inventor. Young v. Van Duser, 16 O. G., 95.

A mere aggregation or combination of old devices is not patentable when the elements are unchanged in *function and effect*. They are patentable when, "by the action of the elements upon each other, or by their joint action on their common object, they perform additional functions and accomplish additional effects." Robinson on Patents, Sec. 154.

A change of shape enabling an instrument to perform new functions is invention. Wilson v. Coon, 18 Blatch. 532; Collar Co. v. White, 7 O. G., 690, 877.

A patent which is simply for a method of transacting business or keeping accounts is not valid. U. S. Credit System Co. v. American Indemnity Co., 63 O. G., 318.

The law requires that manufacturers of patented articles give notice to the public that the goods are patented by marking thereon the date of the patent or giving equivalent notice. When this law is not complied with, only nominal damages can be recovered. Wilson v. Singer Mfg. Co., 4 Bann. & A. 637; McCourt v. Brodie, 5 Fisher, 384.

To prevent fraudulent impositions on the public it is forbidden that unpatented articles be stamped "Patented," and where this is done with intention to deceive, a penalty of one hundred dollars and costs for each article so stamped is provided. Any person may bring action against such offenders. Walker v. Hawxhurst, 5 Blatch. 494; Tompkins v. Butterfield, 25 Fed. Rep. 556.

A patentee is bound by the limitations imposed on his patent, whether they are voluntary or enforced by the Patent Office, and if he accepts claims not covering his entire invention he abandons the remainder. Toepfer v. Goetz, 41 O. G., 933.

Claims should be construed, if possible, to sustain the patentee's right to all he has invented. Ransom v. Mayor of N. Y. (1856), Fisher, 252.

The assignor of a patented invention is estopped from denying the validity of his own patent or his own title to the interest transferred. He cannot become the owner of an older patent and hold it against his assignee. Robinson on Patents, Sec. 787, and notes.

Any assignment which does not convey to the assignee the entire and unqualified monopoly which the patentee holds in the territory specified, or an undivided interest in the entire monopoly, is a mere license. Sanford v. Messer, 2 O. G., 470.

## FOREIGN PATENTS.

CANADA, DOMINION OF.—The laws of Canada follow somewhat closely the practice in the United States. The term of a patent is 18 years. The general practice, however, is to divide the fees, making payment only for a term of six years at one time. Applications are subjected to examination as to novelty and usefulness, as in the United States. The application must be filed in Canada not later than during the year following the issue of the United States or other foreign patent. If the inventor neglects to file his application within the 12 months, the invention becomes public property. It is not permissible to import the patented article into the Dominion after 12 months from the date of the Canadian patent. Within two years from said date the manufacture and sale of the article under the patent must have been begun. These exactions may be relaxed under certain conditions.

GREAT BRITAIN.—The term of the patent is 14 years. An examination is made in Great Britain to ascertain whether the invention has been disclosed in the specifications of British patents granted within fifty years of the filing of the British application. While this is the extent of the examination by the Patent Office, it will be sufficient to invalidate a British patent to show in court that the invention was published, or was in public use, in Great Britain before the priority of the British application. In Great Britain the true inventor should apply for the patent in his own name; but if the invention has been conceived in a foreign country, the first introducer may obtain the patent whether he be the true inventor or not. Under these circumstances, therefore, a foreign assignee may apply for the patent in his own name without the true inventor being known. After the fourth year there are annual taxes, gradually increasing in amount. The patent becomes void if the tax is not paid. No time is set within which the manufacture of the invention must be commenced, but after three years if the manufacture has not been begun, the patentee may be compelled to grant licenses, or the patent may be declared invalid.

FRANCE.—The term of a patent is 15 years. There is no examination as to novelty, and the patent is granted to the first applicant, whether or not he be the true inventor. The life of the patent depends upon the payment of annual taxes. The patent must be worked in France within two years of the issue of the patent. If these conditions are not complied with, the patent becomes public property.

GERMANY.—The term of a patent is 15 years. The patent is issued to the first applicant, but if he is not the true inventor he should, before filing the application, obtain the written consent of the inventor. The application is subjected to a rigid examination. The patent is subject to an annual progressive tax, and must be worked within a period of three years.

AUSTRIA.—The term of a patent is 15 years. The practice is somewhat similar to the practice in Germany, although the examination is generally not so exacting. The patent is subject to an annual tax and it must be worked within a period of three years.

HUNGARY.—The term of a patent is 15 years. The laws are similar to those of Germany. There is a progressive annual tax and the patent must be worked within a period of three years.

BELGIUM.—The term of a patent is 20 years. The first applicant obtains the patent whether or not he is the true inventor. There is a small annual tax, and the patent should be worked within one year of the working elsewhere.

ITALY.—The term of a patent is 15 years. The patent is granted to the first applicant. The patent is subject to an annual tax, and the working must take place within two years.

RUSSIA.—The term of the patent is 15 years. The patent is subject to the payment of annual taxes and must be worked within five years.

SPAIN.—The term of the patent is 20 years, subject to the payment of annual taxes. It must be worked within three years. The patent is issued to the first applicant, whether or not he be the true inventor.

SWITZERLAND.—The term of the patent is 15 years, subject to an annual tax. Working must take place within three years. Only the true inventor or his assignee can obtain a patent.

NORWAY.—Term of patent is 15 years, subject to a small annual tax. The patent must be worked within three years. The application must be filed in the name of the true inventor or his legal representative. Applica-

tion must be filed within six months of the publication of any prior patent.

SWEDEN.—Term of patent is 15 years, subject to payment of an annual tax. The conditions are very similar to the laws of Norway, but the application should be filed before the issuing of a prior foreign patent.

DENMARK.—The laws are similar to those of Sweden.

PORTUGAL.—The term varies from 1 to 15 years, the fees payable depending upon the term of the patent.

HOLLAND.—A Patent bill introduced.

AUSTRALASIA. — The Australasia patent protects an invention in Victoria, New South Wales, Queensland, South Australia, Tasmania and Western Australia, but not in New Zealand, which has its own patent laws. The term of the Australia patent is 14 years, a tax being due before the expiration of the seventh year. When the patent is not worked the patentee may be required to give license for a reasonable consideration.

NEW ZEALAND.—The term of the patent is 14 years, taxes being due before the end of the fourth and seventh years. There are no requirements as to working.

BRITISH INDIA.—The patent is granted for 14 years, and closely follows the British practice. The application should be filed within one year of the issue of the patent in any other country.

PORTO RICO.—It is possible to procure protection for industrial property by registering a certified copy of the United States patent with the Civil Governor and complying with the other legal formalities.

PHILIPPINES.—The modus operandi is the same as that just described as applying to Porto Rico.

CUBA.—Since Cuba has become an independent republic it has established a patent system. The term of the patent is 17 years. Working should be established within one year. No taxes after the issue of the patent.

MEXICO.—The term is 20 years. There are no taxes after the issue of the patent.

SOUTH AMERICAN REPUBLICS.—Patents are issued by all the South American republics. The principal countries in which patent protection is sought are Brazil, in which the laws are quite favorable to foreigners, Chile and Argentina. Patents are also frequently secured in Venezuela, Peru, Ecuador, Colombia and Paraguay, but only for certain classes of invention, owing to the expense involved in procuring the patents.

SOUTH AFRICA.—Patents are obtainable in four important states, Cape Colony, Transvaal, Congo Free State and Orange Free State.

JAPAN has recently enacted a system of patent laws on a liberal basis.

CHINA has no patent laws nor patent office.

The conditions under which foreigners may file applications in the countries having patent laws vary greatly, and no attempt has been made to specify under what conditions applications may be filed. In most countries, however, the issuance of a prior foreign patent will either defeat the issuance of the patent subsequently applied for in another country, or will render the patent invalid even if it is issued. Great care should be taken, therefore, to avoid having a foreign patent issue at such a time as to endanger the life of the patent at home. The many dangers and difficulties which have arisen from the differing laws and the varying practice in different countries have led to the establishment of rectifying provisions which lessen these various disparities and rendering them innocuous.

—*Encyclopedia Americana.*

## PATENT LAWS OF THE UNITED STATES.

[The Constitutional Provision.—The Congress shall have power * * * to promote the progress of Science and Useful Arts, by securing for limited Times to Authors and Inventors the exclusive Right to their respective Writings and Discoveries.]

### STATUTES.

ORGANIZATION OF THE PATENT OFFICE.

TITLE XI, Rev. Stat., p. 80:

Sec. 475. There shall be in the Department of the Interior an office known as the Patent Office, where all records, books, models, drawings, specifications, and other papers and things pertaining to patents shall be safely kept and preserved.

Sec. 476. There shall be in the Patent Office a Commissioner of Patents, one Assistant Commissioner, and three examiners-in-chief, who shall be appointed by the President, by and with the advice and consent of the Senate. All other officers, clerks, and employees authorized by law for the

Office shall be appointed by the Secretary of the Interior, upon the nomination of the Commissioner of Patents.

COURTS.

Sec. 629. The circuit courts shall have original jurisdiction * * * of all suits at law or in equity arising under the patent copyright laws of the United States.

TITLE XIII, Rev. Stat., p. 169:

Sec. 893. Copies of the specifications and drawings of foreign letters patent certified as provided in the preceding section, shall be prima facie evidence of the fact of the granting of such letters patent, and of the date and contents thereof.

Sec. 894. The printed copies of specifications and drawings of patents, which the Commissioner of Patents is authorized to print for gratuitous distribution, and to deposit in the capitols of the States and Territories, and in the clerks' offices of the district courts, shall, when certified by him and authenticated by the seal of his office, be received in all courts as evidence of all matters therein contained.

Sec. 1537. No patented article connected with marine engines shall hereafter be purchased or used in connection with any steam vessels of war until the same shall have been submitted to a competent board of naval engineers, and recommended by such board, in writing, for purchase and use.

TITLE XVII, Rev. Stat., p. 292:

Sec. 1673. No royalty shall be paid by the United States to any one of its officers or employees for the use of any patent for the system, or any part theeof, mentioned in the preceding section, nor for any such patent in which said officers or employees may be directly or indirectly interested.

PATENTS.

TITLE LX, Rev. Stat., 1878, chap. 1, p. 945:

Sec. 4883. All patents shall be issued in the name of the United States of America, under the seal of the Patent Office, and shall be signed by the Commissioner of Patents, and they shall be recorded, together with the specifications, in the Patent Office in books to be kept for that purpose.

Sec. 4884. Every patent shall contain a short title or description of the invention or discovery, correctly indicating its nature and design, and a grant to the patentee, his heirs or assigns, for the term of seventeen years, of the exclusive right to make, use, and vend the invention or discovery throughout the United States and the Territories thereof, referring to the specification for the particulars thereof. A copy of the specification and drawings shall be annexed to the patent and be a part thereof.

Sec. 4885. Every patent shall bear date as of a day not later than six months from the time at which it was passed and allowed and notice thereof was sent to the applicant or his agent; and if the final fee is not paid within that period the patent shall be withheld.

Sec. 4886. Any person who has invented or discovered any new and useful art, machine, manufacture, or composition of matter, or any new and useful improvements thereof, not known or used by others in this country, before his invention or discovery thereof, and not patented or described in any printed publication in this or any foreign country, before his invention or discovery thereof, or more than two years prior to his application, and not in public use or on sale in this country for more than two years prior to his application, unless the same is proved to have been abandoned, may, upon payment of the fees required by law, and other due proceeding had, obtain a patent therefor.

The Secretary of the Interior and the Commissioner of Patents are authorized to grant any officer of the Government, except officers and employees of the Patent Office, a patent for any invention of the classes mentioned in section 4886 of the Revised Statutes when such invention is used or to be used in the public service, without the payment of any fee: *Provided*, That the applicant in his application shall state that the invention described therein, if patented, may be used by the Government, or any of its officers or employees in prosecution of work for the Government, or by any other person in the United States, without the payment to him of any royalty thereon, which stipulation shall be included in the patent.

Sec. 4887. No person otherwise entitled thereto shall be debarred from receiving a patent for his invention or discovery, nor shall any patent be declared invalid by reason of its having been first patented or caused to be patented by the inventor or his legal representatives or assigns in a foreign

country, unless the application for said foreign patent was filed more than twelve months, in cases within the provisions of section 4886 of the Revised Statutes, and four months in cases of designs, prior to the filing of the application in this country, in which case no patent shall be granted in this country.

An application for patent for an invention or discovery or for a design filed in this country by any person who has previously regularly filed an application for a patent for the same invention, discovery, or design in a foreign country which, by treaty, convention, or law, affords similar privileges to citizens of the United States shall have the same force and effect as the same application would have if filed in this country on the date on which the application for patent for the same invention, discovery, or design was first filed in such foreign country, provided the application in this country is filed within twelve months in cases within the provisions of section 4886 of the Revised Statutes, and within four months in cases of designs, from the earliest date on which any such foreign application was filed. But no patent shall be granted on an application for patent for an invention or discovery or a design which had been patented or described in a printed publication in this or any foreign country more than two years before the date of the actual filing of the application in this country, or which had been in public use or on sale in this country for more than two years prior to such filing.

Sec. 4888. Before any inventor or discoverer shall receive a patent for his invention or discovery, he shall make application therefor, in writing, to the Commissioner of Patents, and shall file in the Patent Office a written description of the same, and of the manner and process of making, constructing, compounding, and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art or science to which it appertains, or with which it is most nearly connected, to make, construct, compound, and use the same; and in case of a machine, he shall explain the principle thereof, and the best mode in which he has contemplated applying that principle, so as to distinguish it from other inventions; and he shall particularly point out and distinctly claim the part, improvement, or combination which he claims as his invention or discovery. The specification and claim shall be signed by the inventor and attested by two witnesses.

Sec. 4889. When the nature of the case admits of drawings, the applicant shall furnish one copy signed by the inventor or his attorney in fact, and attested by two witnesses, which shall be filed in the Patent Office; and a copy of the drawing, to be furnished by the Patent Office, shall be attached to the patent as a part of the specification.

Sec. 4890. When the invention or discovery is of a composition of matter, the applicant, if required by the Commissioner, shall furnish specimens of ingredients and of the composition, sufficient in quantity for the purpose of experiment.

Sec. 4891. In all cases which admit of representation by model, the applicant, if required by the Commissioner, shall furnish a model of convenient size to exhibit advantageously the several parts of his invention or discovery.

Sec. 4892. The applicant shall make oath that he does verily believe himself to be the original and first inventor or discoverer of the art, machine, manufacture, composition, or improvement for which he solicits a patent; that he does not know and does not believe that the same was ever before known or used; and shall state of what country he is a citizen. Such oath may be made before any person within the United States authorized by law to administer oaths, or, when the applicant resides in a foreign country, before any minister, charge d'affaires, consul, or commercial agent holding commission under the Government of the United States, or before any notary public, judge, or magistrate having an official seal and authorized to administer oaths in the foreign country in which the applicant may be, whose authority shall be proved by certificate of a diplomatic or consular officer of the United States.

Sec. 4893. On the filing of any such application and the payment of the fees required by law, the Commissioner of Patents shall cause an examination to be made of the alleged new invention or discovery; and if on such examination it shall appear that the claimant is justly entitled to a patent under the law, and that the same is sufficiently useful and important, the

Commissioner shall issue a patent therefor.

Sec. 4894. All applications for patents shall be completed and prepared for examination within one year after the filing of the application, and in default thereof, or upon failure of the applicant to prosecute the same within one year after any action therein, of which notice shall have been given to the applicant, they shall be regarded as abandoned by the parties thereto, unless it be shown to the satisfaction of the Commissioner of Patents that such delay was unavoidable.

Sec. 4895. Patents may be granted and issued or reissued to the assignee of the inventor or discoverer; but the assignment must first be entered of record in the Patent Office. And in all cases of an application by an assignee for the issue of a patent, the application shall be made and the specification sworn to by the inventor or discoverer; and in all cases of an application for a reissue of any patent, the application must be made and the corrected specification signed by the inventor or discoverer, if he is living, unless the patent was issued and the assignment made before the eighth day of July, 1870.

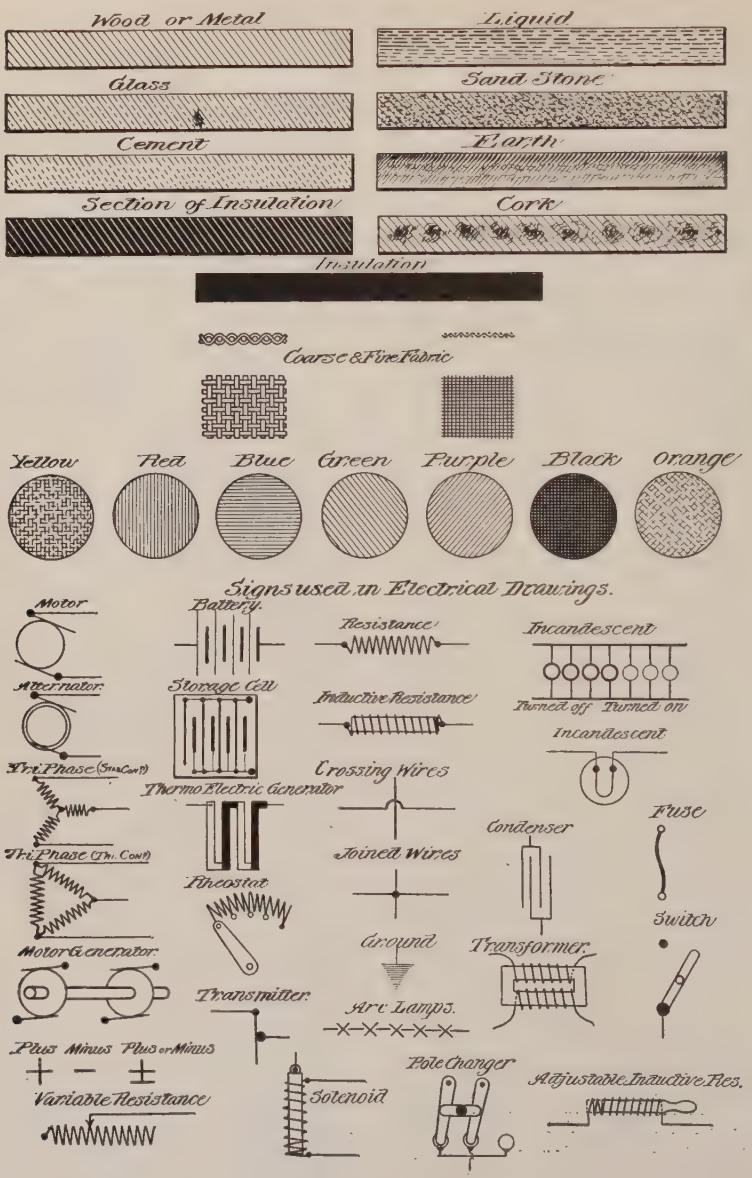
Sec. 4896. When any person, having made any new invention or discovery for which a patent might have been granted, dies before a patent is granted, the right of applying for and obtaining the patent shall devolve on his executor or administrator, in trust for the heirs at law of the deceased, in case he shall have died intestate; or if he shall have left a will disposing of the same, then in trust for his devisees, in as full manner and on the same terms and conditions as the same might have been claimed or enjoyed by him in his lifetime; and when the application is made by such legal representatives, the oath or affirmation required to be made shall be so varied in form that it can be made by them. The executor or administrator duly authorized under the law of any foreign country to administer upon the estate of the deceased inventor shall, in case the said inventor was not domiciled in the United States at the time of his death, have the right to apply for and obtain the patent. The authority of such foreign executor or administrator shall be proved by certificate of a diplomatic or consular officer of the United States.

Sec. 4897. Any person who has an interest in an invention or discovery, whether as inventor, discoverer, or assignee, for which a patent was ordered to issue upon the payment of the final fee, but who fails to make payment thereof within six months from the time at which it was passed and allowed, and notice thereof was sent to the applicant or his agent, shall have a right to make an application for a patent for such invention or discovery the same as in the case of an original application. But such second application must be made within two years after the allowance of the original application. But no person shall be held responsible in damages for the manufacture or use of any article or thing for which a patent was ordered to issue under such renewed application prior to the issue of the patent. And upon the hearing of renewed applications preferred under this section, abandonment shall be considered as a question of fact.

Sec. 4898. Every patent or any interest therein shall be assignable in law by an instrument in writing, and the patentee or his assigns or legal representatives may in like manner grant and convey an exclusive right under his patent to the whole or any specified part of the United States. An assignment, grant, or conveyance shall be void as against any subsequent purchaser for mortgagee or a valuable consideration, without notice, unless it is recorded in the Patent Office within three months from the date thereof.

If any such assignment, grant, or conveyance of any patent shall be acknowledged before any notary public of the several States or Territories or the District of Columbia, or any commissioner of the United States Circuit Court, or before any secretary of legation or consular officer authorized to administer oaths or perform notarial acts under section 1750 of the Revised Statutes, the certificate of such acknowledgment, under the hand and official seal of such notary or other officer, shall be prima facie evidence of the execution of such assignment, grant or conveyance.

Sec. 4899. Every person who purchases of the inventor or discoverer, or, with his knowledge and consent, constructs any newly invented or discovered machine, or other patentable article, prior to the application by the inventor or discoverer for a patent, or who sells or uses one so constructed, shall have the right to use, and vend




CONVENTIONAL SIGNS USED IN U. S. PATENT OFFICE DRAWINGS.

to others to be used, the specific thing so made or purchased, without liability therefor.

Sec. 4900. It shall be the duty of all patentees, and their assigns and legal representatives, and of all persons making or vending any patented article for or under them, to give sufficient notice to the public that the same is patented either by fixing thereon the word "patented," together with the day and year the patent was granted; or when, from the character of the article, this cannot be done, by fixing to it, or to the package wherein one or more of them is inclosed, a label containing the like notice; and in any suit for infringement, by the party failing so to mark, no damages shall be recovered by the plaintiff, except on proof that the defendant was duly notified of the infringement, and continued, after such notice, to make, use, or vend the article so patented.

Sec. 4901. Every person who, in any manner, marks upon anything made, used, or sold by him for which he has not obtained a patent, the name or any imitation of the name of any persons who has obtained a patent therefor, without the consent of such patentee, or his assigns or legal representatives; or

Who, in any manner, marks upon or affixes to any such patented article the word "patent" or "patentee," or the words "letters patent," or any word of like import, with intent to imitate or counterfeit the mark or device of the patentee, without having the license or consent of such patentee or his assigns or legal representatives; or

Who, in any manner, marks upon or affixes to any unpatented article the word "patent" or any word importing that the same is patented, for the purpose of deceiving the public, shall be liable, for every such offense, to a penalty of not less than one hundred dollars, with costs; one-half of said penalty to the person who shall sue for the same, and the other to the use of the United States, to be recovered by suit in any district court of the United States within whose jurisdiction such offense may have been committed.

Sec. 4902. Any person who makes any new invention or discovery and desires further time to mature the same may, on payment of the fees required by law, file in the Patent Office a caveat setting forth the design thereof and of its distinguishing characteristics and praying protection of his right until he shall have matured his invention. Such caveat shall be filed in the confidential archives of the office and preserved in secrecy, and shall be operative for the term of one year from the filing thereof; and if application is made within the year by any other persons for a patent with which such caveat would in any manner interfere the Commissioner shall deposit the description, specification, drawings, and model of such application in like manner in the confidential archives of the office, and give notice thereof by mail to the person by whom the caveat was filed. If such person desires to avail himself of his caveat he shall file his description, specifications, drawings, and model within three months from the time of placing the notice in the post-office in Washington, with the usual time required for transmitting it to the caveator added thereto, which time shall be indorsed on the notice.

Sec. 4903. Whenever, on examination, any claim for a patent is rejected, the Commissioner shall notify the applicant thereof, giving him briefly the reasons for such rejection, together with such information and references as may be useful in judging of the propriety of renewing his application or of altering his specification; and if, after receiving such notice, the applicant persists in his claim for a patent, with or without altering his specifications, the Commissioner shall order a re-examination of the case.

Sec. 4904. Whenever an application is made for a patent which, in the opinion of the Commissioner, would interfere with any pending application, or with any unexpired patent, he shall give notice thereof to the applicants, or applicant and patentee, as the case may be, and shall direct the primary examiner to proceed to determine the question of priority of invention. And the Commissioner may issue a patent to the party who is adjudged the prior inventor, unless the adverse party appeals from the decision of the primary examiner, or of the board of examiners-in-chief, as the case may be, within such time, not less than twenty days, as the Commissioner shall prescribe.

Sec. 4905. The Commissioner of Patents may establish rules for taking affidavits and depositions required in cases pending in the Patent Office, and such affidavits and depositions may be

taken before any officer authorized by law to take depositions to be used in the courts of the United States or of the State where the officer resides.

Sec. 4906. The clerk of any court of the United States, for any district or Territory wherein testimony is to be taken for use in any contested case pending in the Patent Office, shall, upon the application of any party thereto, or of his agent or attorney, issue a subpœna for any witness residing or being within such district or Territory, commanding him to appear and testify before any officer in such district or Territory authorized to take depositions and affidavits, at any time and place in the subpœna stated. But no witness shall be required to attend at any place more than forty miles from the place where the subpœna is served upon him.

Sec. 4907. Every witness duly subpœnaed and in attendance shall be allowed the same fees as are allowed to witnesses attending the courts of the United States.

Sec. 4908. Whenever any witness, after being duly served with such subpœna, neglects or refuses to appear, or after appearing refuses to testify, the judge of the court whose clerk issued the subpœna may, on proof of such neglect or refusal, enforce obedience to the process, or punish the disobedience, as in other like cases. But no witness shall be deemed guilty of contempt for disobeying such subpœna, unless his fees and traveling expenses in going to, returning from, and one day's attendance at the place of examination, are paid or tendered him at the time of the service of the subpœna; nor for refusing to disclose any secret invention or discovery made or owned by himself.

Sec. 4909. Every applicant for a patent or for the reissue of a patent, any of the claims of which have been twice rejected, and every party to an interference, may appeal from the decision of the primary examiner, or of the examiner in charge of interferences in such case, to the board of examiners-in-chief; having once paid the fee for such appeal.

Sec. 4910. If such party is dissatisfied with the decision of the examiners-in-chief, he may, on payment of the fee prescribed, appeal to the Commissioner in person.

Sec. 4911. If such party, except a party to an interference, is dissatisfied with the decision of the Commissioner, he may appeal to the Supreme Court of the District of Columbia, sitting in banc.

Sec. 4912. When an appeal is taken to the Supreme Court of the District of Columbia, the appellant shall give notice thereof to the Commissioner, and file in the Patent Office within such time as the Commissioner shall appoint, his reasons of appeal, specifically set forth in writing.

Sec. 4913. The court shall, before hearing such appeal, give notice to the Commissioner of the time and place of the hearing, and on receiving such notice the Commissioner shall give notice of such time and place in such manner as the court may prescribe, to all parties who appear to be interested therein. The party appealing shall lay before the court certified copies of all the original papers and evidence in the case, and the Commissioner shall furnish the court with the grounds of his decision, fully set forth in writing, touching all the points involved by the reasons of appeal. And at the request of any party interested, or of the court, the Commissioner and the examiners may be examined under oath, in explanation of the principles of the thing for which a patent is demanded.

Sec. 4914. The court, on petition, shall hear and determine such appeal, and revise the decision appealed from in a summary way, on the evidence produced before the Commissioner, at such early and convenient time as the court may appoint; and the revision shall be confined to the points set forth in the reasons of appeal. After hearing the case the court shall return to the Commissioner a certificate of its proceedings and decision, which shall be entered of record in the Patent Office, and shall govern the further proceedings in the case. But no opinion or decision of the court in any such case shall preclude any person interested from the right to contest the validity of such patent in any court wherein the same may be called in question.

Sec. 4915. Whenever a patent on application is refused, either by the Commissioner of Patents or by the Supreme Court of the District of Columbia upon appeal from the Commissioner, the applicant may have remedy by bill in equity; and the court having cognizance thereof, on notice to adverse parties and other due proceedings had, may adjudge that such applicant is entitled, according to law, to receive a patent for his invention, as specified in his claim, or for

any part thereof, as the facts in the case may appear. And such adjudication, if it be in favor of the right of the applicant, shall authorize the Commissioner to issue such patent on the applicant filing in the Patent Office a copy of the adjudication, and otherwise complying with the requirements of law. In all cases where there is no opposing party, a copy of the bill shall be served on the Commissioner; and all the expenses of the proceeding shall be paid by the applicant, whether the final decision is in his favor or not.

R. S., U. S., Sup., Vol. 2, c. 74, Feb. 9, 1893. *Be it enacted, etc.*, That there shall be, and there is hereby, established in the District of Columbia a court, to be known as the court of appeals of the District of Columbia.

Sec. 6. That the said court of appeals shall establish a term of the court during each and every month in each year excepting the months of July and August.

Sec. 8. That any final judgment or decree of the said court of appeals may be re-examined and affirmed, reversed, or modified by the Supreme Court of the United States, upon writ of error or appeal, in all causes in which the matter in dispute, exclusive of costs, shall exceed the sum of five thousand dollars, in the same manner and under the same regulations as heretofore provided for in cases of writs of error on judgment or appeals from decrees rendered in the supreme court of the District of Columbia;

And also in cases, without regard to the sum or value of the matter in dispute, wherein is involved the validity of any patent or copyright, or in which is drawn in question the validity of a treaty or statute of or an authority exercised under the United States.

*Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled*, That in any case heretofore made final in the court of appeals of the District of Columbia it shall be competent for the Supreme Court to require, by certiorari or otherwise, any such case to be certified to the Supreme Court for its review and determination, with the same power and authority in the case as if it had been carried by appeal or writ of error to the Supreme Court.

Sec. 9. That the determination of appeals from the decision of the Commissioner of Patents, now vested in the general term of the supreme court of the District of Columbia, in pursuance of the provisions of section 780 of the Revised Statutes of the United States, relating to the District of Columbia, shall hereafter be and the same is hereby vested in the court of appeals created by this act;

And in addition, any party aggrieved by a decision of the Commissioner of Patents in any interference case may appeal therefrom to said court of appeals.

TITLE LX, Rev. Stat., 1878, p. 950:

Sec. 4916. Whenever any patent is inoperative or invalid, by reason of a defective or insufficient specification, or by reason of the patentee claiming as his own invention or discovery more than he had a right to claim as new, if the error has arisen by inadvertence, accident, or mistake, and without any fraudulent or deceptive intention, the Commissioner shall, on the surrender of such patent and the payment of the duty required by law, cause a new patent for the same invention, and in accordance with the corrected specification, to be issued to the patentee, or, in case of his death or of an assignment of the whole or any undivided part of the original patent, then to his executors, administrators, or assigns, for the unexpired part of the term of the original patent. Such surrender shall take effect upon the issue of the amended patent. The Commissioner may, in his discretion, cause several patents to be issued for distinct and separate parts of the thing patented, upon demand of the applicant, and upon payment of the required fee for a reissue for each of such reissued letters patent. The specifications and claim in every such case shall be subject to revision and restriction in the same manner as original applications are. Every patent so reissued, together with the corrected specifications, shall have the same effect and operation in law, on the trial of all actions for causes thereafter arising, as if the same had been originally filed in such corrected form; but no new matter shall be introduced into the specification, nor in case of a machine patent shall the model or drawings be amended, except each by the other; but when there is neither model nor drawing, amendments may be made upon proof satisfactory to the Commissioner that such new matter or amendment was a part of the original invention, and was omitted from the specification by inad-

vertence, accident, or mistake, as aforesaid.

Sec. 4917. Whenever, through inadvertence, accident, or mistake, and without any fraudulent or deceptive intention, a patentee has claimed more than that of which he was the original or first inventor or discoverer, his patent shall be valid for all that part which is truly and justly his own, provided the same is a material or substantial part of the thing patented; and any such patentee, his heirs or assigns, whether of the whole or any sectional interest therein, may, on payment of the fee required by law, make disclaimer of such parts of the thing patented as he shall not choose to claim or to hold by virtue of the patent or assignment, stating therein the extent of his interest in such patent. Such disclaimer shall be in writing, attested by one or more witnesses, and recorded in the patent office; and it shall thereafter be considered as part of the original specification to the extent of the interest possessed by the claimant and by those claiming under him after the record thereof. But no such disclaimer sball affect any action pending at the time of its being filed, except so far as may relate to the question of unreasonable neglect or delay in filing it.

Sec. 4918. Whenever there are interfering patents, any person interested in any one of them, or in the working of the invention claimed under either of them, may have relief against the interfering patentee, and all parties interested under him, by suit in equity against the owners of the interfering patent; and the court, on notice to adverse parties, and other due proceedings had according to the course of equity, may adjudge and declare either of the patents void in whole or in part, or inoperative, or invalid in any particular part of the United States, according to the interest of the parties in the patent or the invention patented. But no such judgment or adjudication shall affect the right of any person except the parties to the suit and those deriving title under them subsequent to the rendition of such judgment.

Sec. 4919. Damages for the infringement of any patent may be recovered by action on the case, in the name of the party interested either as patentee, assignee, or grantee. And whenever in any such action a verdict is rendered for the plaintiff, the court may enter judgment thereon for any sum above the amount found by the verdict as the actual damages sustained, according to the circumstances of the case, not exceeding three times the amount of such verdict, together with the costs.

Sec. 4920. In any action for infringement the defendant may plead the general issue, and, having given notice in writing to the plaintiff or his attorney thirty days before, may prove on trial any one or more of the following special matters:

First.—That for the purpose of deceiving the public the description and specification filed by the patentee in the Patent Office was made to contain less than the whole truth relative to his invention or discovery, or more than is necessary to produce the desired effect; or,

Second.—That he had surreptitiously or unjustly obtained the patent for that which was in fact invented by another, who was using reasonable diligence in adapting and perfecting the same; or,

Third.—That it has been patented or described in some printed publication prior to his supposed invention or discovery thereof, or more than two years prior to his application for a patent therefor; or,

Fourth.—That he was not the original and first inventor or discoverer of any material and substantial part of the thing patented; or,

Fifth.—That it had been in public use or on sale in this country for more than two years before his application for a patent, or had been abandoned to the public.

And in notices as to proof of previous invention, knowledge, or use of the thing patented, the defendant shall state the names of the patentees and the dates of their patents, and when granted, and the names and residences of the persons alleged to have invented or to have had the prior knowledge of the thing patented, and where and by whom it had been used; and if any one or more of the special matters alleged shall be found for the defendant, judgment shall be rendered for him with costs. And the like defenses may be pleaded in any suit in equity for relief against an alleged infringement; and proofs of the same may be given upon like notice in the answer of the defendant, and with the like effect.

Sec. 4921. The several courts vested with jurisdiction of cases arising under the patent laws shall have power to grant injunctions according to

the course and principles of courts of equity, to prevent the violation of any right secured by patent, on such terms as the court may deem reasonable; and upon a decree being rendered in any such case for an infringement the complainant shall be entitled to recover, in addition to the profits to be accounted for by the defendant, the damages the complainant has sustained thereby; and the court shall assess the same or cause the same to be assessed under its direction. And the court shall have the same power to increase such damages, in its discretion, as is given to increase the damages found by verdicts in actions in the nature of actions of trespass upon the case.

But in any suit or action brought for the infringement of any patent there shall be no recovery of profits or damages for any infringement committed more than six years before the filing of the bill of complaint or the issuing of the writ in such suit or action, and this provision shall apply to existing causes of action.

Sec. 4922. Whenever, through inadvertence, accident, or mistake, and without any wilful default or intent to defraud or mislead the public, a patentee has, in his specification, claimed to be the original and first inventor or discoverer of any material or substantial part of the thing patented, of which he was not the original and first inventor or discoverer, every such patentee, his executors, administrators, and assigns, whether of the whole or any sectional interest in the patent, may maintain a suit at law or in equity, for the infringement of any part thereof, which was bona fide his own, if it is a material and substantial part of the thing patented, and definitely distinguishable from the parts claimed without right, notwithstanding the specifications may embrace more than that of which the patentee was the first inventor or discoverer. But in every such case in which a judgment or decree shall be rendered for the plaintiff, no costs shall be recovered unless the proper disclaimer has been entered at the Patent Office before the commencement of the suit. But no patentee shall be entitled to the benefits of this section if he has unreasonably neglected or delayed to enter a disclaimer.

Sec. 4923. Whenever it appears that a patentee, at the time of making his application for the patent, believed himself to be the original and first inventor or discoverer of the thing patented, the same shall not be held to be void on account of the invention or discovery, or any part thereof, having been known or used in a foreign country, before his invention or discovery thereof, if it had not been patented or described in a printed publication.

DESIGNS.

Sec. 4929. Any person who has invented any new, original, and ornamental design for an article of manufacture, not known or used by others in this country before his invention thereof, and not patented or described in any printed publication in this or any foreign country before his invention thereof, or more than two years prior to his application, and not in public use or on sale in this country for more than two years prior to his application, unless the same is proved to have been abandoned, may, upon payment of the fees required by law and other due proceedings had, the same as in cases of invention or discoveries covered by section 4886, obtain a patent therefor.

Sec. 4930. The Commissioner may dispense with models of designs when the design can be sufficiently represented by drawings or photographs.

Sec. 4931. Patents for designs may be granted for the term of three years and six months, or for seven years, or for fourteen years, as the applicant may, in his application, elect.

Sec. 4932. Patentees of designs issued prior to the second day of March, 1861, shall be entitled to extension of their respective patents for the term of seven years, in the same manner and under the same restrictions as are provided for the extension of patents for inventions or discoveries issued prior to the second day of March, 1861.

Sec. 4933. All the regulations and provisions which apply to obtaining or protecting patents for inventions or discoveries not inconsistent with the provisions of this Title, shall apply to patents for designs.

## CHAPTER 105.—An Act to Amend the Law Relating to Patents, Trade-Marks, and Copyrights.

*Be it enacted, etc.*, That hereafter, during the term of letters patent for a design, it shall be unlawful for any person other than the owner of said letters patent, without the license of such owner, to apply the design se-

cured by such letters patent, or any colorable imitation thereof, to any article of manufacture for the purpose of sale, or to sell or expose for sale any article of manufacture to which such design or colorable imitation shall, without the license of the owner, have been applied, knowing that the same has been so applied. Any person violating the provisions, or either of them, of this section, shall be liable in the amount of two hundred and fifty dollars; and in case the total profit made by him from the manufacture or sale, as aforesaid, of the article or articles to which the design, or colorable imitation thereof, has been applied, exceeds the sum of two hundred and fifty dollars, he shall be further liable for the excess of such profit over and above the sum of two hundred and fifty dollars; and the full amount of such liability may be recovered by the owner of the letters patent, to his own use, in any circuit court of the United States having jurisdiction of the parties, either by action at law or upon a bill in equity for an injunction to restrain such infringement.

Sec. 2. That nothing in this act contained shall prevent, lessen, impeach, or avoid any remedy at law or in equity which any owner of letters patent for a design, aggrieved by the infringement of the same, might have had if this act had not been passed; but such owner shall not twice recover the profit made from the infringement.

FEES.

Sec. 4934. The following shall be the rates for patent fees: On filing each original application for a patent, except in design cases, $15.00. On issuing each original patent, except in design cases, $20.00. In design cases: For three years and six months; $10.00; for seven years, $15.00; for fourteen years, $30.00. On filing each caveat, $10.00. On every application for the reissue of a patent, $30.00. On filing each disclaimer, $10.00. On an appeal for the first time from the primary examiners to the examiners-in-chief, $10.00. On every appeal from the examiners-in-chief to the Commissioner, $20.00. For certified copies of patents and other papers, including certified printed copies, 10 cents per hundred words. For recording every assignment, agreement, power of attorney, or other paper, of three hundred words or under, $1.00; of over three hundred and under one thousand words, $2.00; of over one thousand words, $3.00. For copies of drawings, the reasonable cost of making them.

Sec. 4935. Patent fees may be paid to the Commissioner of Patents, or to the Treasurer, or any of the assistant treasurers of the United States, or to any of the designated depositaries, national banks, or receivers of public money, designated by the Secretary of the Treasury for that purpose; and such officer shall give the depositor a receipt or certificate of deposit therefor. All money received at the Patent Office, for any purpose, or from any source whatever, shall be paid into the Treasury as received, without any deduction whatever.

Sec. 4936. The Treasurer of the United States is authorized to pay back any sum or sums of money to any person who has through mistake paid the same into the Treasury, or to any receiver or depositary, to the credit of the Treasury, as for fees accruing at the Patent Office, upon a certificate thereof being made to the Treasurer by the Commissioner of Patents.

PATENT RIGHTS VEST IN ASSIGNEE IN BANKRUPTCY.

Sec. 5046. All property conveyed by the bankrupt in fraud of his creditors; all rights in equity, choses in action, patent rights, and copyrights; all debts due him, or any person for his use, and all liens and securities therefor; and all his rights of action for property or estate, real or personal, and for any cause of action which he had against any person arising from contract or from the unlawful taking or detention, or injury to the property of the bankrupt; and all his rights of redeeming such property or estate; together with the like right, title, power, and authority to sell, manage, dispose of, sue for, and recover or defend the same, as the bankrupt might have had if no assignment had been made, shall, in virtue of the adjudication of bankruptcy and the appointment of his assignee, but subject to the exceptions stated in the preceding section, be at once vested is [in] such assignee.

Sec. 70. Title to Property. The trustee of the estate of a bankrupt, upon his appointment and qualification, and his successor or successors, if he shall have one or more, upon his or their appointment and qualification, shall in turn be vested by operation of law with the

title of the bankrupt, as of the date he was adjudged a bankrupt, except in so far as it is to property which is exempt, to all (1) documents relating to his property; (2) interests in patents, patent rights, copyrights, and trade-marks.

## LABELS.

CHAPTER 301.—AN ACT TO AMEND THE LAW RELATING TO PATENTS, TRADE-MARKS, AND COPYRIGHTS.

*Be it enacted, etc.* [Section 1], That no person shall maintain an action for the infringement of his copyright unless he shall give notice thereof by inserting in the several copies of every edition published, on the title page or the page immediately following it, if it be a book; or if a map, chart, musical composition, print, cut, engraving, photograph, painting, drawing, chromo, statue, statuary, or model or design intended to be perfected and completed as a work of the fine arts, by inscribing upon some visible portion thereof, or of the substance on which the same shall be mounted, the following words, viz.: "Entered according to act of Congress, in the year ——, by A. B., in the office of the Librarian of Congress, at Washington"; or, at his option, the word "Copyright," together with the year the copyright was entered, and the name of the party by whom it was taken out, thus: "Copyright, 18—, by A. B."

Sec. 2. That for recording and certifying any instrument of writing for the assignment of a copyright, the Librarian of Congress shall receive from the persons to whom the service is rendered, $1.00; and for every copy of an assignment, $1.00; said fee to cover, in either case, a certificate of the record, under seal of the Librarian of Congress; and all fees so received shall be paid into the Treasury of the United States.

Sec. 3. That in the construction of this act, the words "engraving," "cut," and "print," shall be applied only to pictorial illustrations or works connected with the fine arts, and no prints or labels designed to be used for any other articles of manufacture shall be entered under the copyright law, but may be registered in the Patent Office. And the Commissioner of Patents is hereby charged with the supervision and control of the entry or registry of such prints or labels, in conformity with the regulations provided by law as to copyright of prints, except that there shall be paid for recording the title of any print or label not a trade-mark, $6.00, which shall cover the expense of furnishing a copy of the record under the seal of Commissioner of Patents, to the party entering the same.

Sec. 4. That all laws and parts of laws inconsistent with the foregoing provisions be, and the same are hereby repealed.

Sec. 5. That this act shall take effect on and after the first day of August, 1874.

## TRADE-MARKS.

[*The Constitutional Provision.*—The Congress shall have power * * * (3) to regulate commerce with foreign nations, and among the several States, and with the Indian tribes. Art. I. sec. 8.]

NEW TRADE-MARK ACT, WHICH WENT IN FORCE APRIL 1, 1905.

*Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,* That the owner of a trade-mark used in commerce with foreign nations, or among the several States, or with Indian tribes, provided such owner shall be domiciled within the territory of the United States, or resides in or is located in any foreign country which, by treaty, convention, or law, affords similar privileges to the citizens of the United States, may obtain registration for such trade-mark by complying with the following requirements: First, by filing in the Patent Office an application therefor, in writing, addressed to the Commissioner of Patents, signed by the applicant, specifying his name, domicile, location, and citizenship; the class of merchandise and the particular description of goods comprised in such class to which the trade-mark is appropriated; a description of the trade-mark itself, and a statement of the mode in which the same is applied and affixed to goods, and the length of time during which the trade-mark has been used. With this statement shall be filed a drawing of the trade-mark, signed by the applicant, or his attorney, and such number of specimens of the trade-mark, as actually used, as may be required by the Commissioner of Patents. Second, by paying into the Treasury of the United States the sum of ten dollars, and otherwise complying with the requirements of this Act and such regulations as may be prescribed by the Commissioner of Patents.

Sec. 2. That the application prescribed in the foregoing section, in order to create any right whatever in favor of the party filing it, must be accompanied by a written declaration verified by the applicant, or by a member of the firm or an officer of the corporation or association applying, to the effect that the applicant believes himself or the firm, corporation, or association in whose behalf he makes the application to be the owner of the trade-mark sought to be registered, and that no other person, firm, corporation, or association, to the best of the applicant's knowledge and belief, has the right to such use, either in the identical form or in such near resemblance thereto as might be calculated to deceive; that such trade-mark is used in commerce among the several States, or with foreign nations, or with Indian tribes, and that the description and drawing presented truly represent the trade-mark sought to be registered. If the applicant resides or is located in a foreign country, the statement required shall, in addition to the foregoing, set forth that the trade-mark has been registered by the applicant, or that an application for the registration thereof has been filed by him in the foreign country in which he resides or is located, and shall give the date of such registration, or the application therefor, as the case may be, except that in the application in such cases it shall not be necessary to state that the mark has been used in commerce with the United States or among the States thereof. The verification required by this section may be made before any person within the United States authorized by law to administer oaths, or, when the applicant resides in a foreign country, before any minister, chargé d'affaires, consul, or commercial agent holding commission under the Government of the United States, or before any notary public, judge, or magistrate having an official seal and authorized to administer oaths in the foreign country in which the applicant may be whose authority shall be proved by a certificate of a diplomatic or consular officer of the United States.

Sec. 3. That every applicant for registration of a trade-mark, or for renewal of registration of a trade-mark, who is not domiciled within the United States, shall, before the issuance of the certificate of registration, as hereinafter provided for, designate, by a notice in writing, filed in the Patent Office, some person residing within the United States on whom process or notice of proceedings affecting the right of ownership of the trade-mark of which such applicant may claim to be the owner, brought under the provisions of this Act or under other laws of the United States, may be served, with the same force and effect as if served upon the applicant or registrant in person. For the purposes of this Act it shall be deemed sufficient to serve such notice upon such applicant, registrant, or representative by leaving a copy of such process or notice addressed to him at the last address of which the Commissioner of Patents has been notified.

Sec. 4. Provides that foreigners shall have the benefit of the date of foreign filing if the United States application is filed within four months after the foreign application.

Sec. 5. That no mark by which the goods of the owner of the mark may be distinguished from other goods of the same class shall be refused registration as a trade-mark on account of the nature of such mark unless such mark—

(a) Consists of or comprises immoral or scandalous matter;

(b) Consists of or comprises the flag or coat-of-arms or other insignia of the United States, or any simulation thereof, or of any State or municipality, or of any foreign nation: *Provided*, That trade-marks which are identical with a registered or known trade-mark owned and in use by another, and appropriated to merchandise of the same descriptive properties, or which so nearly resemble a registered or known trade-mark owned and in use by another, and appropriated to merchandise of the same descriptive properties, as to be likely to cause confusion or mistake in the mind of the public, or to deceive purchasers, shall not be registered: *Provided*, That no mark which consists merely in the name of an individual, firm, corporation, or association, not written, printed, impressed, or woven in some particular or distinctive manner or in association with a portrait of the individual, or merely in words or devices which are descriptive of the goods with which they are used, or of the character or quality of such goods, or merely a geographical name or term, shall be registered under the terms of this Act: *Provided further*, That no portrait of a living individual may be registered as a trade-mark, except by the consent of

such individual, evidenced by an instrument in writing: *And provided further*, That nothing herein shall prevent the registration of any mark used by the applicant or his predecessors, or by those from whom title to the mark is derived, in commerce with foreign nations or among the several States, or with Indian tribes, which was in actual and exclusive use as a trade-mark of the applicant or his predecessors from whom he derived title for ten years next preceding the passage of this Act.

Sec. 6. That on the filing of an application for registration of a trade-mark which complies with the requirements of this Act, and the payment of the fees herein provided for, the Commissioner of Patents shall cause an examination thereof to be made; and if on such examination it shall appear that the applicant is entitled to have his trade-mark registered under the provisions of this Act, the Commissioner shall cause the mark to be published at least once in the Official Gazette of the Patent Office. Any person who believes he would be damaged by the registration of a mark may oppose the same by filing notice of opposition, stating the grounds therefor, in the Patent Office within thirty days after the publication of the mark sought to be registered, which said notice of opposition shall be verified by the person filing the same before one of the officers mentioned in section two of this Act. If no notice of opposition is filed within said time the Commissioner shall issue a certificate of registration therefor, as hereinafter provided for. If on examination an application is refused, the Commissioner shall notify the applicant, giving him his reasons therefor.

Sec. 7. That in all cases where notice of opposition has been filed the Commissioner of Patents shall notify the applicant thereof and the grounds therefor.

Whenever application is made for the registration of a trade-mark which is substantially identical with a trade-mark appropriated to goods of the same descriptive properties, for which a certificate of registration has been previously issued to another, or for registration of which another has previously made application, or which so nearly resembles such trade-mark, or a known trade-mark owned and used by another, as, in the opinion of the Commissioner, to be likely to be mistaken therefor by the public, he may declare that an interference exists as to such trade-mark, and in every case of interference or opposition to registration he shall direct the examiner in charge of interferences to determine the question of the right of registration to such trade-mark, and of the sufficiency of objections to registration, in such manner and upon such notice to those interested as the Commissioner may by rules prescribe.

The Commissioner may refuse to register the mark against the registration of which objection is filed, or may refuse to register both of two interfering marks, or may register the mark, as a trade-mark, for the person first to adopt and use the mark, if otherwise entitled to register the same, unless an appeal is taken, as hereinafter provided for, from his decision, by a party interested in the proceeding, within such time (not less than twenty days) as the Commissioner may prescribe.

Secs. 8 and 9. These sections provide for appeals.

Sec. 10. Provides for recording assignments of Trade-Marks.

Sec. 11. Provides for the issuing of the certificate of registration and the printing of copies.

Sec. 12. This section fixes the term of twenty years [unless a previous foreign registration expires sooner], and also provides for renewal.

Sec. 13. This section provides for the cancellation of a trade-mark wrongfully registered.

Secs. 14 and 15. These sections regulate the fees and repayment.

Sec. 16. That the registration of a trade-mark under the provisions of this Act shall be prima facie evidence of ownership. Any person who shall, without the consent of the owner thereof, reproduce, counterfeit, copy, or colorably imitate any such trade-mark and affix the same to merchandise of substantially the same descriptive properties as those set forth in the registration, or to labels, signs, prints, packages, wrappers, or receptacles intended to be used upon or in connection with the sale of merchandise of substantially the same descriptive properties as those set forth in such registration, and shall use, or shall have used, such reproduction, counterfeit, copy, or colorable imitation in commerce among the several States, or with a foreign nation, or with the Indian tribes, shall be liable to an action for damages therefor at the suit of the owner thereof; and whenever in any such action a verdict is rendered for

the plaintiff, the court may enter judgment therein for any sum above the amount found by the verdict as the actual damages, according to the circumstances of the case, not exceeding three times the amount of such verdict, together with the costs.

Secs. 17, 18, 19, 20. These deal with the powers of the courts.

Sec. 21. That no action or suit shall be maintained under the provisions of this Act in any case when the trade-mark is used in unlawful business, or upon any article injurious in itself, or which mark has been used with the design of deceiving the public in the purchase of merchandise, or has been abandoned, or upon any certificate of registration fraudulently obtained.

Sec. 22. This section provides that a court of equity may order the cancellation of one of two interfering registrations.

Sec. 23. That nothing in this Act shall prevent, lessen, impeach, or avoid any remedy at law or in equity which any party aggrieved by any wrongful use of any trade-mark might have had if the provisions of this Act had not been passed.

Sec. 24. This section applies the new law to applications filed under the old law.

Sec. 25. That any person who shall procure registration of a trade-mark, or entry thereof, in the office of the Commissioner of Patents by a false or fraudulent declaration or representation, oral or in writing, or by any false means, shall be liable to pay any damages sustained in consequence thereof to the injured party, to be recovered by an action on the case.

Sec. 26. This section empowers the Commissioner to make rules.

Sec. 27. This section provides that registered marks may be recorded in the United States ports of entry, and when so recorded foreign goods bearing infringing marks will be excluded.

Sec. 28. That it shall be the duty of the registrant to give notice to the public that a trade-mark is registered, either by affixing thereon the words "Registered in U. S. Patent Office," or abbreviated thus, "Reg. U. S. Pat. Off.," or when, from the character or size of the trade-mark, or from its manner of attachment to the article to which it is appropriated, this cannot be done, then by affixing a label containing a like notice to the package or receptacle wherein the article or articles are inclosed; and in any suit for infringement by a party failing so to give notice of registration no damages shall be recovered, except on proof that the defendant was duly notified of infringement, and continued the same after such notice.

Sec. 29. That in construing this Act the following rules must be observed, except where the contrary intent is plainly apparent from the context thereof: The United States includes and embraces all territory which is under the jurisdiction and control of the United States. The word "States" includes and embraces the District of Columbia, the Territories of the United States, and such other territory as shall be under the jurisdiction and control of the United States. The terms "person" and "owner," and any other word or term used to designate the applicant or other entitled to a benefit or privilege or rendered liable under the provisions of this Act, include a firm, corporation, or association as well as a natural person. The terms "applicant" and "registrant" embrace the successors and assigns of such applicant or registrant. The term "trade-mark" includes any mark which is entitled to registration under the terms of this Act and whether registered or not, and a trade-mark shall be deemed to be "affixed" to an article when it is placed in any manner in or upon either the article itself or the receptacle or package or upon the envelope or other thing in, by, or with which the goods are packed or inclosed or otherwise prepared for sale or distribution.

Sec. 30. That this Act shall be in force and take effect April first, nineteen hundred and five. All Acts and parts of Acts inconsistent with this Act are hereby repealed except so far as the same may apply to certificates of registration issued under the Act of Congress approved March third, eighteen hundred and eighty-one, entitled "An Act to authorize the registration of trade-marks and protect the same," or under the Act approved August fifth, eighteen hundred and eighty-two, entitled "An Act relating to the registration of trade-marks."

Approved, February 20, 1905.

## HISTORY OF THE AMERICAN PATENT SYSTEM.

The century just closed stands out pre-eminently as the century of invention. It is therefore a fitting time briefly to refer to the origin, establishment, and development of our patent system, to call to mind the debt the United States owes to inventors, and at the same time to point out the advantages that have followed the farseeing wisdom of the framers of the Federal Constitution in incorporating in that instrument paragraph 8 of section 8 of Article I. of the Constitution, which gave to Congress the power "To promote the progress of science and the useful arts by securing for limited times to authors and inventors the exclusive rights to their respective writings and discoveries."

One hundred years ago the population of the United States was less than 6,000,000, and there was not a single city within our borders having a population of 75,000. The population of New York, Philadelphia, Baltimore, and Boston was less than the present population of Minneapolis. The latter city and its sister city of St. Paul, Chicago, Omaha, and Kansas City were unknown. Not a steam propelled vessel was in use, nor was there a mile of railroad in the United States. The electric telegraph and telephone were unknown. Our exports consisted of agricultural products. There was scarcely any well-developed line of manufacture, and our wants in that line were supplied by imports. It had been the policy of England to suppress manufacturing in its colonies. In 1634 a law was passed in Virginia for the encouragement of textile manufactures, but it was promptly annulled by England. In 1731 she enacted a law prohibiting the carriage of woolen goods and hats from one colony to another. In 1750 a woollen hat factory in Massachusetts was declared to be a nuisance and suppressed. No carpets were made in the colonies until after 1776, except rag carpets. In 1800 carpets were in this country a luxury. Even up to 1850 there was not a power loom for carpet making in the United States.

What is true in the textile art is equally true of most of the other arts.

Though the country was an agricultural one, little progress had been made in the manufacture of agricultural implements. It was not until 1819 that an iron plow was produced in this country. The reaper appeared in 1833 and a successful thresher not until 1850. Up to the time of the Civil War there is no question but that the country continued to be an agricultural one. It is true that during the first sixty years of the last century our manufactures steadily and rapidly increased in kind and in extent, but our population increased even more rapidly, so that we consumed what we manufactured and were still largely dependent upon the import of manufactured articles. But in the last few years a great reversal, not only in sentiment but in conditions, has occurred; the commercial relations of the United States with the great trading nations of the world have rapidly changed, so that the excess of imports of manufactured articles has turned into an excess of exports of such articles.

One need not look far for the cause of this. It lies in the economy of manufacture arising from the use of labor-saving devices, mainly the invention of our own people, which has enabled us to compete in many lines of manufacture, notwithstanding the higher scale of wages paid in this country, with similar articles manufactured by any or all nations. To employ these devices to the best advantage requires the intelligence of the American workmen, and the result is due to the combination of witty inventions and thinking men. Witless men behind witty machines would be of no use. To the patent system more than to any other cause are we indebted for the industrial revolution of the century.

President Washington realized the importance of formulating a law to stimulate inventions, and in his first annual message to Congress, in 1790, said:

"I can not forbear intimating to you the expediency of giving effectual encouragement as well to the introduction of new and useful inventions from abroad as to the exertion of skill and genius in producing them at home."

Congress was quick to act, and on April 10, 1790, the first law upon the subject was enacted. It constituted the Secretary of State, the Secretary of War, and the Attorney-General a board to consider all applications for patents. Owing to the fires that have destroyed the early records of the Patent Office, some question has arisen

as to the number of patents issued under this act; but from the best information obtainable I place the number at fifty-seven. The first patent issued was to Samuel Hopkins, July 31, 1790, for making pot and pearl ashes.

The act of 1793 superseded the act of 1790, and remained in force as amended from time to time until the act of 1836 was passed. The act of 1793 was the only act ever passed in this country which provided for the issuance of Letters Patent without the requirement of an examination into the novelty and utility of the invention for which the patent was sought.

The act of 1836, with modifications, remained in force until the revision of the patent laws in 1870. This revision was largely a consolidation of the statutes then in force.

Under the revision of the statutes of the United States in 1874 the act of 1870 was repealed; but the revision substantially re-enacted the provisions of the act of 1870.

Under the acts of 1790 and 1793 Letters Patent were granted for a term of fourteen years. There was no provision for extension; but while the act of 1793 was in force Congress extended some thirteen patents.

The act of 1836 provided that Letters Patent should be granted for a term of fourteen years, and provision was made for an extension for a term of seven years upon due application and upon a proper showing. Until 1848 petitions for extensions were passed upon by a board consisting of the Secretary of State, the Commissioner of Patents, and the Solicitor of the Treasury. After that time power was vested solely in the Commissioner of Patents.

The patent act of March 2, 1861 (section 16), provided that all patents thereafter granted should remain in force for a term of seventeen years from the date of issue, and the extension of such patents was prohibited.

The consolidated patent act of 1870, while providing that patents should be granted for a term of seventeen years, also provided that patents granted prior to March 2, 1861, might, upon due application and a proper showing, be extended by the Commissioner of Patents for a term of seven years from the expiration of the first term.

By the revision of the patent laws in 1874 the prohibition against the extension of patents was dropped, and since that time Congress has had the power to extend Letters Patent. Congress extended five patents granted under the act of 1836, and in nine instances authorized patentees to apply to the Commissioner of Patents for extension of their patents. So far as I have been able to discover, no patent granted for a term of seventeen years has been extended by Congress.

It was not until 1842 that the statute was passed authorizing the grant of patents for designs. Under that act design patents were granted for seven years. Subsequently provisions were made for granting them for terms of three and one-half, seven, and fourteen years, at the election of the applicant.

By the act of March 2, 1861, the Board of Examiners-in-Chief was established. Prior to that time, and during the incumbency of Commissioner Holt, temporary boards of examiners to decide appeals had been appointed by him, and later on he created a permanent board of three examiners who were to decide on appeal rejected cases and submit their decisions to him for approval.

The act of 1870 made the first provision for an Assistant Commissioner and an Examiner of Interferences. Another provision in that act was the power given the Commissioner, subject to the approval of the Secretary of the Interior, to establish regulations for the conduct of proceedings in the Office.

On January 1, 1898, an act passed March 3, 1897, went into force. Some of the provisions of this act were that applications for patents should be completed and prepared for examination within one year after the filing of the application and that the applicant should prosecute the same within one year after an action thereon or it should be regarded as abandoned (prior to that time two years was the limit); that an inventor should be debarred from receiving a patent if his invention had been first patented by him or his legal representatives or assigns in a foreign country, provided the application for the foreign patent had been filed more than seven months prior to the filing of the application in this country, and that if the invention for which a patent was applied for had been patented or described in any printed publication in this or any foreign country for more than two years prior to the application a patent could not issue.

The first provision for affording accommodations for the Patent Office was in 1810, when Congress authorized the purchase of a building for the General Post-office and for the office of the Keeper of Patents. The building purchased was known as "Blodgett's Hotel," and stood on the site now occupied by the south front of the building until recently occupied by the Post-office Department, and now used by several bureaus of the Interior Department. The east end of this building was used for the records, models, etc., of the Patent Office. This building was destroyed by fire December 13, 1836. On July 4, 1836, an act was passed appropriating $108.000 for the erection of a suitable building for the accommodation of the Patent Office, and within that month the erection of the building was begun.

It was the present south front of the Patent Office, excluding the south ends of the east and west wings. The basement (which is now the first or ground floor) was to be used for storage and analogous purposes, the first or portico floor for office rooms, and the second floor was to be one large hall with galleries on either side, and to have a vaulted roof. This hall was to be used for exhibition purposes, for the display of models of patented and unpatented inventions, and also as a national gallery of the industrial arts and manufactures.

During the erection of the Patent Office building temporary quarters were provided in the City Hall. In the spring of 1840 the building was completed and the Office moved into it. The sum of $422,011.65 was expended on this building. The patented models were then classified and exhibited in suitable glass cases, while the national gallery was arranged for exhibition of models and specimens.

By the act of March 3, 1849, the Interior Department was established and the Patent Office attached thereto. This same act appropriated $50,000 out of the patent fund to begin the east or Seventh street wing, which was completed in 1852 at a cost of $600,000, $250,000 of which was taken from the revenue of the Patent Office. In 1852 the plans for the entire building, as it now stands, were prepared. The west wing was completed in 1856 and cost $750,000. Work on the north or G street wing was begun the same year. In 1867 this wing was finished at a cost of $575,000. The entire building cost $2,347,011.65.

Since July 28, 1836, 667,173 patents for inventions, and since 1842 34,018 patents for designs have been issued by this office. Many of these patents are for minor improvements, but among them may be found a very large number covering the most remarkable and valuable inventions, which have added untold sums to the world's wealth, revolutionized the old arts, created new ones, brought old-time luxuries within the reach of all, and made life doubly worth living. These contributions have come from men and women, white and colored. To many inventors more than a hundred patents have been issued. The following are some of the inventors who have received more than that number between 1872 and 1900, both years inclusive:

| | |
|---|---|
| Thomas A. Edison | 742 |
| Francis H. Richards | 619 |
| Elihu Thomson | 444 |
| Charles E. Scribner | 374 |
| Luther C. Crowell | 293 |
| Edward Weston | 280 |
| Rudolph M. Hunter | 276 |
| Charles J. Van Depoele (deceased) | 245 |
| George Westinghouse | 239 |
| John W. Hyatt | 209 |
| Freeborn F. Raymond, 2d | 182 |
| Sydney H. Short | 178 |
| Rudolf Eickemeyer (deceased) | 171 |
| Milo G. Kellogg | 159 |
| Walter Scott | 156 |
| Arthur J. Moxham | 150 |
| Cyrus W. Saladee | 148 |
| Louis Goddu | 146 |
| Hiram S. Maxim | 146 |
| George D. Burton | 144 |
| Lewis H. Nash | 142 |
| Edwin Norton | 141 |
| Abbot Augustus Low | 137 |
| Philip Diehl | 137 |
| James C. Anderson | 135 |
| Edward J. Brooks | 133 |
| Elmer A. Sperry | 132 |
| Peter K. Dederick | 128 |
| Hosea W. Libbey | 127 |
| James F. McElroy | 121 |
| William N. Whiteley | 121 |
| Horace Wyman | 118 |
| Frank Rhind | 117 |
| Louis K. Johnson | 114 |
| Warren H. Taylor | 112 |
| James M. Dodge | 111 |
| George H. Reynolds | 110 |
| Talbot C. Dexter | 109 |
| James H. Northrop | 102 |

From 1790 to March 1, 1895, some 5,535 patents were granted to wom-

en. It is a fair estimate that out of every 1,000 patents one is granted to a woman. As a rule women take out but one patent, although there are many exceptions. While the majority of patents granted them are for improvements in wearing apparel and in articles for household use, they have invented and received patents for adding machines, windmills, horseshoes, agricultural implements, and fire escapes.

To some 165 colored inventors about 400 patents have been issued. Twenty-eight patents have been issued to one and to another 22. So far as the records show, Henry Blair, of Maryland, was the first colored patentee. In 1834 he received a patent for a corn planter, and in 1836 one for a cotton planter. The character of their inventions follows lines suggested by their employment. Employed in the field and in the house, improvements in agricultural implements and articles of domestic use predominate. The sphere of their inventive effort has widened with the added opportunities afforded them to engage in mechanical vocations. They have made contributions to the electric arts and steam engineering, and many improvements in railway appliances and paper-bag machines. Before the Civil War the master of a slave living in Mississippi made application for a patent, but the Attorney-General held in an opinion reported in vol. 9, Attorney-General's Opinions, page 171, that an invention of a slave, though it be new and useful, could not be patented.

In May, 1802, President Jefferson appointed Dr. William Thornton as a clerk at $1,400 per year, to have charge of the issuance of patents. He took the title of Superintendent, and continued to act in that capacity until his death, March 28, 1828. He was succeeded by Dr. William P. Jones, who acted until his removal in the early part of President Jackson's administration. John D. Craig followed Dr. Jones, and in 1834 he was succeeded by B. F. Pickett, who served but a brief period. The last Superintendent was Henry L. Ellsworth, who became the first Commissioner under the act of 1836, and served until 1845. The other Commissioners under that act were:

Edmund Burke, May 4, 1845.
Thomas Ewbank, May 9, 1849.
Silas H. Hodges, November 8, 1852.
Charles Mason, May 16, 1853.
Joseph Holt, September 10, 1857.
William D. Bishop, May 27, 1859.
Philip F. Thomas, February 16, 1860.
D. P. Holloway, March 28, 1861.
T. C. Theaker, August 17, 1865.
Elisha Foote, July 29, 1868.
Samuel S. Fisher, April 26, 1869.

Commissioner Fisher continued as Commissioner for a short time under the act of 1870. Other Commissioners under that act have been:

M. D. Leggett, January 16, 1871.
John M. Thacher, November 4, 1874.
R. H. Duell, October 1, 1875.
Ellis Spear, January 30, 1877.
H. E. Paine, November 1, 1878.
E. M. Marble, May 7, 1880.
Benjamin Butterworth, November 1, 1883.
M. V. Montgomery, March 23, 1885.
B. J. Hall, April 12, 1887.
C. E. Mitchell, April 1, 1889.
William E. Simonds, August 1, 1891.
John S. Seymour, March 31, 1893.
Benjamin Butterworth, April 7, 1897.
Charles H. Duell, February 3, 1898.
F. I. Allen, April 11, 1901.

Commissioner Fisher was the first to publish his decisions and to have the copies of the specifications and drawings made by photo-lithography. He also instituted the practice of requiring competitive examinations for entrance to and promotions in the examining force of the office.

Beginning in 1843 and annually thereafter the Patent Office reports were published, which, until 1853, contained merely an alphabetical index of the names of the inventors, a list of the expired patents, and the claims of the patents granted during the week. In 1853 and afterward small engraved copies of a portion of the drawings were added to the reports to explain the claims.

The act of 1870 authorized the Commissioner to print copies of the claims of the current issues of patents and of such laws, decisions, and rules as were necessary for the information of the public. In conformity with this provision there was published weekly a list giving the numbers, titles, and claims of the patents issued during the week immediately preceding, together with the names and residences of the patentees. This list was first published under the name of The Official Gazette of the United States Patent Office, on January 3, 1872. In July, 1872, portions of the drawings were introduced to illustrate the

claims in the patented cases. The Official Gazette has now become one of the most valuable and important of Government publications. Each Senator and Representative is authorized to designate eight public libraries to receive this publication free. One copy is also furnished free to each member of Congress. It is also sent all over the world in exchange for similar publications by other Governments, and its paid subscription list is constantly increasing.

The American patent system is known and spoken of as the "examination system," in contradistinction to the English system, which has been mainly followed by other nations. The examination system is the ideal system, provided the examination can be made with sufficient care to minimize the likelihood of the issue of patents for inventions not of a patentable nature. The field of search, however, yearly increases, and it becomes more and more difficult through lack of time to make a perfect examination. Something more than two million domestic and foreign patents have been issued, while the number of scientific publications has enormously increased. It is only by means of a perfect classification that this great mass of matter can be so divided as to be conveniently accessible for use in the examination of any individual case.

Of our patent system it has been well said:

"It is generally recognized by the most profound students of our institutions, both at home and abroad, that no one thing has contributed more to the pre-eminence of this country in the industrial arts and in manufactures than the encouragement given by our Constitution and laws to inventors and to investors in patent property."

The system is by no means perfect; but it is generally acknowledged that the patent laws of the United States are more liberal than those of any other country, and that the examination, imperfect though at times it be, gives a value to a United States patent not possessed by a patent issued by a country not having an examination system. It is undoubtedly true that the practice before the Patent Office lacks stability and uniformity by reason of the frequent changes of Commissioners, which prevents the establishment of definite policies. The salaries paid to the Commissioner and Assistant Commissioner, to the examiners in chief, and to the examiners of the various grades are inadequate. It is also true that too many appeals are permitted, and interference proceedings are rendered onerous and complicated by the number of motions and appeals provided by the laws and rules. The most serious defect, however, follows from the power to keep applications in the Office for indefinite times through delays in amending the same. The act of March 3, 1897, was intended to prevent or check this evil; but it has failed of its purpose. At the present time about 75 per cent of the patents granted are issued within one year after being filed, and were it not for the fact that applications are unduly delayed at least 90 per cent would issue within that time. The rights of the public would be protected and very seldom would an injustice be done to an inventor if provision was incorporated into the patent laws providing that unless an application became involved in an interference it should not be permitted to remain in the Patent Office more than three years without abridging its life of seventeen years.

The records of the Office show that there were pending in 1900, 4,829 applications, filed prior to January 1, 1898. Three of these applications were filed in 1880, one in 1881, four in 1882, three in 1884, three in 1885, thirteen in 1886, seven in 1887, thirteen in 1888, nineteen in 1889, twenty-three in 1890, forty-five in 1891, sixty-four in 1892, one hundred and three in 1893, one hundred and fifty-four in 1894, three hundred and sixty-eight in 1895, nine hundred and ninety-two in 1896, and three thousand and eleven in 1897.

It will be seen, therefore, that an application may be kept alive indefinitely, if it be desired. While the list above given embraces only such applications as were filed under the law as it existed prior to January 1, 1898, yet ten years later a similar list will undoubtedly be given, provided the statutes are not amended, for the only difference lies in the fact that amendments now have to be made within a year after the official action instead of two years under the prior act. A law which permits this should be corrected.

It should continue to be the policy of the government of a nation whose inventors have given to the world the cotton-gin and the reaper, the sewing machine and the typewriter, the electric telegraph and telephone, the rotary web perfecting printing press and

the linotype, the incandescent lamp and the phonograph, and thousands of other inventions that have revolutionized every industrial art, to encourage invention in every lawful way and to provide that, so far as may be necessary, the money paid to the Government by inventors be used for their benefit. The wisdom of the policy has been demonstrated.

The world owes as much to inventors as to statesmen or warriors. To them the United States is the greatest debtor, so much have they advanced American manufactures. Their labor-saving machinery does work that it would take millions of men using hand implements to perform. In this century the debt will be piled still higher, for inventors never rest.—Abstract of report for 1900.

C. H. DUELL,
Commissioner of Patents.

## THE COPYRIGHT LAW OF THE UNITED STATES.

CONSTITUTION, 1787.

Art. 1, Sec. 8. The Congress shall have power * * * To promote the progress of science and useful arts, by Securing for Limited Times to Authors and Inventors the Exclusive Right to their Respective Writings and Discoveries.

ACTS OF CONGRESS.

Sec. 4948. All records and other things relating to copyrights and required by law to be preserved, shall be under the control of the Librarian of Congress, and kept and preserved in the Library of Congress.

[The Appropriation Act approved February 19, 1897, provides for the appointment of a "Register of Copyrights, who shall, on and after July 1, 1897, under the direction and supervision of the Librarian of Congress, perform all the duties relating to copyrights, and shall make weekly deposits with the Secretary of the Treasury, and make monthly reports to the Secretary of the Treasury, and to the Librarian of Congress, and shall, on and after July 1, 1897, give bond to the Librarian of Congress, in the sum of $20,000, with approved sureties, for the faithful discharge of his duties."]

Sec. 4949. The seal provided for the office of the Librarian of Congress shall be the seal thereof, and by it all records and papers issued from the office, and to be used in evidence shall be authenticated.

Sec. 4950. The Appropriation Act, approved February 19, 1897, provides: "The Librarian of Congress shall on and after July 1, 1897, give bond, payable to the United States, in the sum of $20,000, with sureties approved by the Secretary of the Treasury, for the faithful discharge of his duties according to law."

Sec. 4951. The Librarian of Congress shall make an annual report to Congress of the number and description of copyright publications for which entries have been made during the year.

Sec. 4952. The author, inventor, designer, or proprietor of any book, map, chart, dramatic or musical composition, engraving, cut, print, or photograph or negative thereof, or of a painting, drawing, chromo, statue, statuary, and of models or designs intended to be perfected as works of the fine arts, and the executors, administrators, or assigns of any such person shall, upon complying with the provisions of this chapter, have the sole liberty of printing, reprinting, publishing, completing, copying, executing, finishing, and vending the same; and, in the case of dramatic composition, of publicly performing or representing it, or causing it to be performed or represented by others; and authors or their assigns shall have exclusive right to dramatize and translate any of their works for which copyright shall have been obtained under the laws of the United States.

In the construction of this act the words "engraving," "cut," and "print," shall be applied only to pictorial illustrations or works connected with the fine arts, and no prints or labels designed to be used for any other articles of manufacture shall be entered under the copyright law, but may be registered in the Patent Office. And the Commissioner of Patents is hereby charged with the supervision and control of the entry or registry of such prints or labels, in conformity with the regulations provided by law as to copyright of prints, except that there shall be paid for recording the title of any print or label, not a trade-mark, $6.00, which shall cover the expense of furnishing a copy of the record, under the seal of the Commissioner of Patents, to the party entering the same.

Sec. 4953. Copyrights shall be granted for the term of twenty-eight years from the time of recording the title thereof, in the manner hereinafter directed.

Sec. 4954. The author, inventor, or designer, if he be still living, or his widow or children, if he be dead, shall have the same exclusive right continued for the further term of fourteen years, upon recording the title of the work or description of the article so secured a second time, and complying with all other regulations in regard to original copyrights, within six months before the expiration of the first term. And such person shall, within two months from the date of said renewal, cause a copy of the record thereof to be published in one or more newspapers, printed in the United States, for the space of four weeks.

Sec. 4955. Copyrights shall be assignable in law by any instrument of writing, and such assignment shall be recorded in the office of the Librarian of Congress within sixty days after its execution; in default of which it shall be void as against any subsequent purchaser or mortgagee for a valuable consideration, without notice.

Sec. 4956. No person shall be entitled to a copyright unless he shall, on or before the day of publication, in this or any foreign country, deliver at the office of the Librarian of Congress, or deposit in the mail within the United States, addressed to the Librarian of Congress, at Washington, D. C., a printed copy of the title of the book, map, chart, dramatic or musical composition, engraving, cut, print, photograph, or chromo, or a description of the painting, drawing, statue, statuary, or a model or design, for a work of the fine arts, for which he desires a copyright; nor unless he shall also, not later than the day of the publication thereof, in this or any foreign country, deliver at the office of the Librarian of Congress, at Washington, D. C., or deposit in the mail within the United States, addressed to the Librarian of Congress, at Washington, D. C., two copies of such copyright book, map, chart, dramatic or musical composition, engraving, chromo, cut, print or photograph, or in case of a painting, drawing, statue, statuary, model or design for a work of the fine arts, a photograph of the same: Provided, That in the case of a book, photograph, chromo, or lithograph, the two copies of the same required to be delivered or deposited as above, shall be printed from type set within the limits of the United States, or from plates made therefrom, or from negatives, or drawings on stone made within the limits of the United States, or from transfers made therefrom. During the existence of such copyright the importation into the United States of any brook, chromo, lithograph, or photograph, so copyrighted, or any edition or editions thereof, or any plates of the same not made from type set, negatives, or drawings on stone made within the limits of the United States, shall be, and is hereby prohibited, except in the cases specified in paragraphs 512 to 516, inclusive, in Section 2 of the act entitled An act to reduce the revenue and equalize the duties on imports and for other purposes, approved October 1, 1890; and except in the case of persons purchasing for use and not for sale, who import subject to the duty thereon, not more than two copies of such books at any one time; and, except in the case of newspapers and magazines, not containing in whole or in part matter copyrighted under the provisions of this act, unauthorized by the author, which are hereby exempted from prohibition of importation;

Provided, nevertheless, That in the case of books in foreign languages, of which only translations in English are copyrighted, the prohibition of importation shall apply only to the translation of the same, and the importation of the books in the original language shall be permitted.

Sec. 4957. The Librarian of Congress shall record the name of such copyright book, or other article, forthwith in a book to be kept for that purpose, in the words following: "Library of Congress, to wit: Be it remembered that on the —— day of ——, A. B., of ——, hath deposited in this office the title of a book (map, chart, or otherwise, as the case may be, or description of the article), the title or description of which is in the following words, to wit: (here insert the title or description), the right whereof he claims as author (originator, or proprietor, as the case may be), in conformity with the laws of the United States respecting copyrights. C. D., Librarian of Congress." And he shall give a copy of the title or description under the seal of the Librarian of Congress, to the proprietor, whenever he shall require it.

Sec. 4958. The Librarian of Congress shall receive from the persons to

whom the services designated are rendered, the following fees: 1. For recording the title or description of any copyright book or other article, 50 cents. 2. For every copy under seal of such record actually given to the person claiming the copyright, or his assigns, 50 cents. [3. For recording and certifying any instrument of writing for the assignment of a copyright, $1.00. 4. For every copy of an assignment, $1.00.] All fees so received shall be paid into the treasury of the United States: Provided, That the charge for recording the title or description of any article entered for copyright, the production of a person not a citizen or resident of the United States, shall be $1.00, to be paid as above into the treasury of the United States, to defray the expenses of lists of copyrighted articles as hereinafter provided for.

And it is hereby made the duty of the Librarian of Congress to furnish to the Secretary of the Treasury copies of the entries of titles of all books and other articles wherein the copyright has been completed by the deposit of two copies of such book printed from type set within the limits of the United States, in accordance with the provisions of this act, and by the deposit of two copies of such other article made or produced in the United States; and the Secretary of the Treasury is hereby directed to prepare and print, at intervals of not more than a week, catalogues of such title-entries for distribution to the collectors of customs of the United States, and to the postmasters of all post-offices receiving foreign mails, and such weekly lists, as they are issued, shall be furnished to all parties desiring them, at a sum not exceeding five dollars per annum, and the Secretary and the Postmaster-General are hereby empowered and required to make and enforce such rules and regulations as shall prevent the importation into the United States, except upon the conditions above specified, of all articles prohibited by this act.

Sec. 4959. The proprietor of every copyright book or other article shall deliver at the office of the Librarian of Congress, or deposit in the mail, addressed to the Librarian of Congress, at Washington, D. C., a copy of every subsequent edition wherein any substantial changes shall be made: Provided, however, That the alterations, revisions, and additions made to books by foreign authors, heretofore published, of which new editions shall appear subsequently to the taking effect of this act, shall be held and deemed capable of being copyrighted as above provided for in this act, unless they form a part of the series in course of publication at the time this act shall take effect.

Sec. 4960. For every failure on the part of the proprietor of any copyright to deliver, or deposit in the mail, either of the published copies, or description, or photograph, required by sections 4956 and 4959, the proprietor of the copyright shall be liable to a penalty of $25.00, to be recovered by the Librarian of Congress, in the name of the United States, in an action in the nature of an action of debt, in any district court of the United States within the jurisdiction of which the delinquent may reside or be found.

The following act in relation to the deposit of copies was approved March 3, 1893: "That any author, inventor, designer, or proprietor of any book, or other article entitled to copyright, who has heretofore failed to deliver in the office of the Librarian of Congress, or in the mail addressed to the Librarian of Congress, two complete copies of such book, or description or photograph of such article, within the time limited by title 60, chapter 3, of the Revised Statutes, relating to copyrights, and the acts in amendment thereof, and has complied with all other provisions thereof, who has, before the first day of March, 1893, delivered at the office of the Librarian of Congress, or deposited in the mail, addressed to the Librarian of Congress two complete printed copies of such book, or description or photograph of such article, shall be entitled to all the rights and privileges of said title sixty, chapter three, of the Revised Statutes and the acts in amendment thereof.

Sec. 4961. The postmaster to whom such copyright book, title, or other article is delivered, shall, if requested, give a receipt therefor; and when so delivered he shall mail it to its destination.

Sec. 4962. No person shall maintain an action for the infringement of his copyright unless he shall give notice thereof by inserting in the several copies of every edition published, on the title-page, or the page immediately following, if it be a book; or if a map, chart, musical composition, print, cut, engraving, photograph, painting, draw-

ing, chromo, statue, statuary, or model or design intended to be perfected and completed as a work of the fine arts, by inscribing upon some visible portion thereof, or of the substance on which the same shall be mounted, the following words, viz.: "Entered according to act of Congress, in the year ——, by A. B., in the office of the Librarian of Congress, at Washington"; or, at his option, the word "Copyright," together with the year the copyright was entered, and the name of the party by whom it was taken out, thus: "Copyright, 18—, by A. B."

That manufacturers of designs for moulded decorative articles, tiles, plaques, or articles of pottery or metal subject to copyright may put the copyright mark prescribed by Section 4962 of the Revised Statutes, and acts additional thereto, upon the back or bottom of such articles, or in such other place upon them as it has heretofore been usual for manufacturers of such articles to employ for the placing of manufacturers, merchants, and trademarks thereon.

Sec. 4963. Every person who shall insert or impress such notice, or words of the same purport, in or upon any book, map, chart, dramatic or musical composition, print, cut, engraving or photograph, or other article, whether such article be subject to copyright or otherwise, for which he has not obtained a copyright, or shall knowingly issue or sell any article bearing a notice of a United States copyright which has not been copyrighted in this country; or shall import any book, photograph, chromo, or lithograph or other article bearing such notice of copyright or words of the same purport, which is not copyrighted in this country, shall be liable to a penalty of $100, recoverable one-half for the person who shall sue for such penalty, and one-half to the use of the United States; and the importation into the United States of any book, chromo, lithograph, or photograph, or other article bearing such notice of copyright, when there is no existing copyright thereon in the United States, is prohibited; and the circuit courts of the United States sitting in equity are hereby authorized to enjoin the issuing, publishing, or selling of any article marked or imported in violation of the United States copyright laws, at the suit of any person complaining of such violation: Provided, That this act shall not apply to any importation of or sale of such goods or articles brought into the United States prior to the passage hereof.

Sec. 4964. Every person who, after the recording of the title of any book and the depositing of two copies of such book as provided by this act, shall, contrary to the provisions of this act, within the term limited, and without the consent of the proprietor of the copyright first obtained in writing, signed in presence of two or more witnesses, print, publish, dramatize, translate, or import, or, knowing the same to be so printed, published, dramatized, translated, or imported, shall sell or expose to sale any copy of such book, shall forfeit every copy thereof to such proprietor, and shall also forfeit and pay such damages as may be recovered in a civil action by such proprietor in any court of competent jurisdiction.

Sec. 4965. If any person, after the recording of the title of any map, chart, dramatic or musical composition, print, cut, engraving, or photograph, or chromo, or of the description of any painting, drawing, statue, statuary, or model or design intended to be perfected and executed as a work of the fine arts, as provided by this act, shall, within the term limited, contrary to the provisions of this act, and without the consent of the proprietor of the copyright first obtained in writing, signed in presence of two or more witnesses, engrave, etch, work, copy, print, publish, dramatize, translate, or import, either in whole or in part, or by varying the main design, with intent to evade the law, or knowing the same to be so printed, published, dramatized, translated, or imported, shall sell or expose to sale any copy of such map, or other article, as aforesaid, he shall forfeit to the proprietor all the plates on which the same shall be copied, and every sheet thereof, either copied or printed, and shall further forfeit $1.00 for every sheet of the same found in his possession, either printing, printed, copied, published, imported, or exposed for sale; and in case of a painting, statue, or statuary, he shall forfeit $10.00 for every copy of the same in his possession, or by him sold or exposed for sale: Provided, however, That in case of any such infringement of the copyright of a photograph made from any object not a work of fine arts, the sum to be recovered in any action brought under the provisions of this section

shall be not less than $100, nor more than $5,000, and: Provided, further, That in case of any such infringement of the copyright of a painting, drawing, statue, engraving, etching, print, or model or design for a work of the fine arts, or of a photograph of a work of the fine arts, the sum to be recovered in any action brought through the provisions of this section shall be not less than $250, and not more than $10,000. One-half of all the foregoing penalties shall go to the proprietors of the copyright and the other half to the use of the United States.

Sec. 4966. Any person publicly performing or representing any dramatic or musical composition for which a copyright has been obtained, without the consent of the proprietor of said dramatic or musical composition, or his heirs or assigns, shall be liable for damages therefor, such damages in all cases to be assessed at such sum, not less than $100 for the first, and $50 for every subsequent performance, as to the court shall appear to be just. If the unlawful performance and representation be wilful and for profit such person or persons shall be guilty of a misdemeanor, and upon conviction be imprisoned for a period not exceeding one year. Any injunction that may be granted upon hearing after notice to the defendant by any circuit court in the United States, or by a judge thereof, restraining and enjoining the performance or representation of any such dramatic or musical composition may be served on the parties against whom such injunction may be granted anywhere in the United States, and shall be operative and may be enforced by proceedings to punish for contempt or otherwise by any other circuit court or judge in the United States; but the defendants in said action, or any or either of them, may make a motion in any other circuit in which he or they may be engaged in performing or representing said dramatic or musical composition to dissolve or set aside the said injunction upon such reasonable notice to the plaintiff as the circuit court or the judge before whom said motion shall be made shall deem proper; service of said motion to be made on the plaintiff in person or on his attorneys in the action. The circuit courts or judges thereof shall have jurisdiction to enforce said injunction and to hear and determine a motion to dissolve the same, as herein provided, as fully as if the action were pending or brought in the circuit in which said motion is made.

The clerk of the court, or judge granting the injunction, shall, when required so to do by the court hearing the application to dissolve or enforce said injunction, transmit without delay to said court a certified copy of all the papers on which the said injunction was granted that are on file in his office.

Sec. 4967. Every person who shall print or publish any manuscript whatever, without the consent of the author or proprietor first obtained shall be liable to the author or proprietor for all damages occasioned by such injury.

Sec. 4968. No action shall be maintained in any case of forfeiture or penalty under the copyright laws, unless the same is commenced within two years after the cause of action has arisen.

Sec. 4969. In all actions arising under the laws respecting copyrights the defendant may plead the general issue, and give the special matter in evidence.

Sec. 4970. The circuit courts, and district courts having the jurisdiction of circuit courts, shall have power, upon bill in equity, filed by any party aggrieved, to grant injunctions to prevent the violation of any right secured by the laws respecting copyrights, according to the course and principles of courts of equity, on such terms as the court may deem reasonable.

Sec. 4971.

[Revised Statutes, title 13, THE JUDICIARY, provides as follows: Chap. 7 (sec. 629). The circuit courts shall have original jurisdiction as follows: * * * Ninth. Of all suits at law or in equity arising under the patent or copyright laws of the United States. A writ of error may be allowed to review any final judgment at law, and an appeal shall be allowed from any final decree in equity hereinafter mentioned, without regard to the sum or value in dispute: First. Any final judgment at law or final decree in equity of any circuit court, or of any district court acting as a circuit court, or of the supreme court of the District of Columbia, or of any Territory, in any case touching patent rights or copyrights. (Rev. Stat., 1878, p. 130.) Chap. 12 (sec. 711). The jurisdiction vested in the courts of the United States in the cases and proceedings hereafter mentioned, shall be exclusive of the courts of the sev-

eral States: * * * Fifth. Of all cases arising under the patent-right or copyright laws of the United States. (Rev. Stat., 1878, pp. 134, 135.) Chap. 18 (sec. 972). In all recoveries under the copyright laws, either for damages, forfeiture, or penalties, full costs shall be allowed thereon. (Rev. Stat., 1878, p. 183.)]

The act approved March 3, 1891 (51st Congress, 1st session, chap. 565: 26 Statutes at Large, pp. 1106-1110), in addition to the amendments, noted above, of sections 4952, 4954, 4956, 4958, 4959, 4963, 4964, 4965, and 4967, provides further as follows:

"That for the purpose of this act each volume of a book in two or more volumes, when such volumes are published separately, and the first one shall not have been issued before this act shall take effect, and each number of a periodical shall be considered an independent publication, subject to the form of copyrighting as above." (Sec. 11.)

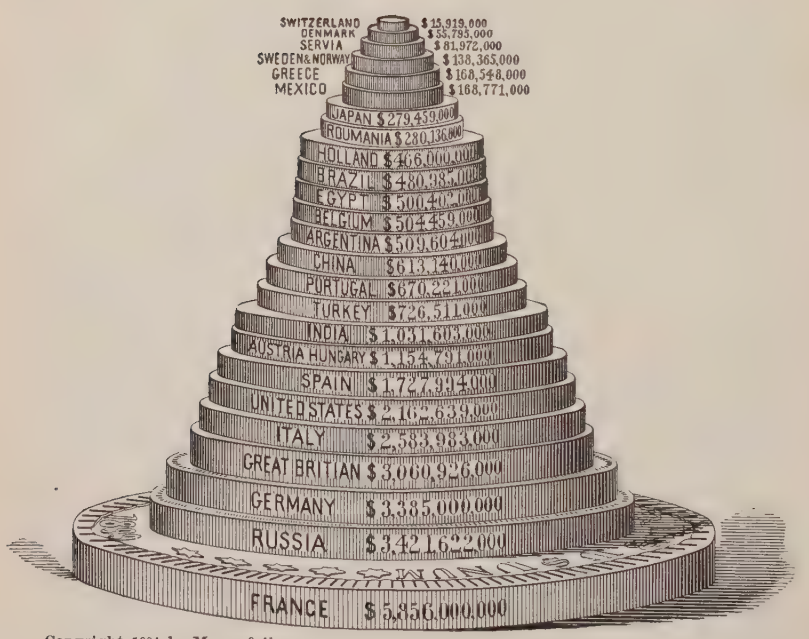
"That this act shall go into effect on the first day of July, 1891." (Sec. 12.)

"That this act shall only apply to a citizen or subject of a foreign state or nation when such foreign state or nation permits to citizens of the United States of America the benefit of copyright on substantially the same basis as its own citizens; or when such foreign state or nation is a party to an international agreement which provides for reciprocity in the granting of copyright, by the terms of which agreement the United States of America may at its pleasure become a party to such agreement. The existence of either of the conditions aforesaid shall be determined by the President of the United States, by proclamation made from time to time as the purposes of this act may require." (Sec. 13.)

[An Act providing for the public printing and binding and the distribution of public documents (January 12, 1895, 53d Congress, 3d session, chap. 23, sec. 52: 28 Statutes at Large, p. 608), provides as follows: The Public Printer shall sell, under such regulations as the Joint Committee on Printing may prescribe, to any person or persons who may apply, additional or duplicate stereotype or electrotype plates from which any Government publication is printed, at a price not to exceed the cost of composition, the metal and making to the Government and 10 per centum added: Provided, That the full amount of the price shall be paid when the order is filed: And provided, further, That no publication reprinted from such stereotype or electrotype plates and no other Government publication shall be copyrighted.]

## AMENDMENT TO THE COPYRIGHT LAW.

Whenever the author or proprietor of a book in a foreign language, which shall be published in a foreign country before the day of publication in this country, or his executors, administrators, or assigns, shall deposit one complete copy of the same, including all maps and other illustrations, in the Library of Congress, Washington, District of Columbia, within thirty days after the first publication of such book in a foreign country, and shall insert in such copy, and in all copies of such book sold or distributed in the United States, on the title page or the page immediately following, a notice of the reservation of copyright in the name of the proprietor, together with the true date of first publication of such book, in the following words: "Published ....., nineteen hundred and ..... Privilege of copyright in the United States reserved under the Act approved March third, nineteen hundred and five, by ....," and shall within twelve months after the first publication of such book in a foreign country file the title of such book and deposit two copies of it in the original language or, at his option, of a translation of it in the English language, printed from type set within the limits of the United States, or from plates made therefrom, containing a notice of copyright, as provided by the copyright laws now in force, he and they shall have during the term of twenty-eight years from the date of recording the title of the book or of the English translation of it, as provided for above, the sole liberty of printing, reprinting, publishing, vending, translating, and dramatizing the said book: *Provided*, That this Act shall only apply to a citizen or subject of a foreign state or nation when such foreign state or nation permits to citizens of the United States of America the benefit of copyright on substantially the same basis as to its own citizens.

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NATIONAL DEBTS OF THE WORLD.

# CHAPTER X.

## MANUFACTURES, EXPORTS AND IMPORTS.

### LOCALIZATION OF SPECIFIED INDUSTRIES, BY STATES: 1900.

| Industry. | Value of Products in Continental United States. | State. | Value of Products in the State Named. | Per Cent of Continental United States in the State Named. |
|---|---|---|---|---|
| Collars and cuffs | $15,769,132 | New York | $15,703,541 | 99.6 |
| Plated and britannia ware | 12,608,770 | Connecticut | 9,538,397 | 75.7 |
| Oysters, canning and preserving | 3,670,134 | Maryland | 2,417,331 | 65.9 |
| Leather gloves and mittens | 16,721,234 | New York | 10,854,221 | 64.9 |
| Clocks | 7,157,856 | Connecticut | 4,545,047 | 63.5 |
| Coke | 35,535,445 | Pennsylvania | 22,282,358 | 62 6 |
| Safes and vaults | 3,927,867 | Ohio | 2,407,655 | 61.3 |
| Whips | 2,734,471 | Massachusetts | 1,651,221 | 60.4 |
| Liquors, vinous | 6,547,310 | California | 3,937,871 | 60.1 |
| Brassware | 17,140,075 | Connecticut | 9,269,159 | 54.1 |
| Iron and steel | 803,968,273 | Pennsylvania | 434,445,200 | 54.0 |
| Carpets and rugs, other than rag | 48,192,351 | Pennsylvania | 23,113,058 | 48.0 |
| Corsets | 14,878,116 | Connecticut | 6,846,946 | 46.0 |
| Boots and shoes, factory product | 261,028,580 | Massachusetts | 117,115,243 | 44.9 |
| Agricultural implements | 101,207,428 | Illinois | 42,033,796 | 41.5 |
| Slaughtering and meat packing, wholesale | 698,206,548 | Illinois | 279,842,835 | 40.1 |
| Turpentine and rosin | 20,344,888 | Georgia | 8,110,468 | 39.9 |
| Cotton, ginning | 14,743,270 | Texas | 5,886,923 | 39.9 |
| Liquors, distilled | 96,793,443 | Illinois | 38,208,076 | 39.5 |
| Glass | 58,539,712 | Pennsylvania | 22,001,130 | 38.9 |
| Hosiery and knit goods | 95,482,566 | New York | 35,886,048 | 37.6 |
| Silk and silk goods | 107,256,258 | New Jersey | 39,966,662 | 37.3 |
| Silverware | 10,569,121 | Rhode Island | 3,834,408 | 36.3 |
| Salt | 7,066,897 | New York | 2,698,691 | 33.9 |
| Cotton goods | 339,200,320 | Massachusetts | 111,125,175 | 32.8 |
| Jewelry | 46,501,181 | Rhode Island | 13,390,620 | 28.6 |
| Leather, tanned, curried, and finished | 201,038,127 | Pennsylvania | 55,615,009 | 27.3 |
| Fur hats | 27,811,187 | Connecticut | 7,546,882 | 27.2 |
| Pottery, terra cotta, and fire-clay products | 44,263,386 | Ohio | 11,851,225 | 26.8 |
| Paper and wood pulp | 127,326,162 | New York | 26,715,628 | 21.0 |

—*Twelfth Census.*

## MANUFACTURING IN THE UNITED STATES—

| Class. | Number of Establishments. | Capital. | Proprietors and Firm Members | Wage-earners. | |
|---|---|---|---|---|---|
| | | | | Average Number. | Total Wages |
| Total | 640,056 | $9,858,205,501 | 708,623 | 5,370,814 | $2,323,055,634 |
| Hand trades | 215,814 | 392,442,255 | 242,154 | 559,130 | 288,118,421 |
| Governmental establishments | 138 | | | | |
| Educational, eleemosynary, and penal institutions | 381 | | | | |
| Establishments with a product of less than $500 | 127,346 | 44,371,111 | 136,054 | 64,671 | 2,117,466 |
| All other establishments | 296,377 | 9,421,392,135 | 330,415 | 4,747,013 | 2,032,819,747 |

Statistics for governmental establishments, educational, eleemosynary, and penal insti-

## MANUFACTURING IN THE UNITED STATES

[Twelfth Census,

| Items. | Date of Census | | |
|---|---|---|---|
| | 1900.[1] | 1890. | 1880. |
| Number of establishments | 512,276 | 355,405 | 253,852 |
| Capital | $9,831,486,500 | $6,525,050,759 | $2,790,272,606 |
| Salaried officials, clerks, etc., number | 397,092 | [2] 461,001 | [3] |
| Salaries | $404,112,794 | [2] $391,984,660 | [3] |
| Wage-earners, average number | 5,314,539 | 4,251,535 | 2,732,595 |
| Total wages | $2,327,295,545 | $1,891,209,696 | $947,953,795 |
| Men, at least 16 years of age | 4,114,348 | 3,326,964 | 2,019,035 |
| Wages | $2,019,954,204 | $1,659,215,858 | [3] |
| Women, at least 16 years of age | 1,031,608 | 803,686 | 531,639 |
| Wages | $281,679,649 | $215,367,976 | [3] |
| Children, under 16 years | 168,583 | 120,885 | 181,921 |
| Wages | $25,661,692 | $16,625,862 | [3] |
| Miscellaneous expenses | $1,027,865,277 | $631,219,783 | [5] |
| Cost of materials used | $7,346,358,979 | $5,162,013,878 | $3,396,823,549 |
| Value of products, incl. custom work, etc. | $13,010,036,514 | $9,372,378,843 | $5,369,579,191 |

[1] Includes, for comparative purposes, 85 governmental establishments in the District of Columbia having products valued at $9,887,355, the statistics for such establishments for 1890 not being separable.

[2] Includes proprietors and firm members, with their salaries; number only reported in 1900, but not included in this table.

[3] Not reported separately.

[4] Decrease.

[5] Not reported.

NOTE.—Exact comparisons between the censuses shown in this table are difficult and sometimes impossible on account of changes which have taken place from census to census in the form of inquiries contained in the schedules, in the industries canvassed, and in the methods of compilation. Comparisons between the censuses of 1890 and 1900 are more exact than has ever before been the case; but even between these two censuses there are certain important differences in the forms of inquiry, or the methods of handling the statistics in compilation, to which careful attention should be paid.

1. Capital.—It cannot be assumed that any true comparability exists between the statistics on this subject elicited prior to 1890. At the census of 1880 the question read: "Capital (real and personal) invested in the business." At the census of 1890 live capital, i.e., cash on hand, bills receivable, unsettled ledger accounts, raw materials, stock in process of manufacture, finished products on hand, and other sundries, was for the first time included as a separate and distinct item of capital, and the capital invested in realty was divided between land, buildings, and machinery. The form of this inquiry at the census of 1890 and 1900 was so similar that comparison may be safely made.

2. Salaried Officials.—No comparison of the statistics of the number and salaries or salaried officials of any character can be made between the reports of any censuses. Not until the census of 1890 did the census begin to differentiate sharply between salaried officials, i.e.,

## SUMMARY FOR ALL ESTABLISHMENTS: 1900.

| Miscellaneous Expenses. | Cost of Materials Used. Total. | Purchased in Raw State. | Purchased in Partially Manufactured Form. | Fuel, Freight, etc. | Value of Products, Including Custom Work and Repairing. |
|---|---|---|---|---|---|
| $1,030,110,125 | $7,363,132,083 | $2,391,668,276 | $4,648,561,271 | $322,902,536 | $13,058,562,917 |
| 124,623,253 | 482,736,991 | 8,851,162 | 462,510,619 | 11,375,210 | 1,183,615,478 |
| ..... | 6,917,518 | 60,576 | 6,607,447 | 249,495 | 22,010,391 |
| ..... | 3,690,916 | 1,037,343 | 2,365,089 | 288,484 | 6,640,692 |
| 2,524,681 | 8,895,774 | 1,431,529 | 7,437,420 | 26,825 | 29,762,675 |
| 902,962,191 | 6,860,890,884 | 2,380,287,666 | 4,169,640,696 | 310,962,522 | 11,816,533,681 |

tutions, and establishments with a product of less than $500, are included in Table only.

## —COMPARATIVE SUMMARY: 1850 TO 1900.

Vols. VII. and VIII.

| Date of Census. 1870. | 1860. | 1850. | Per Cent of Increase. 1890 to 1900. | 1880 to 1890. | 1870 to 1880. | 1860 to 1870. | 1850 to 1860. |
|---|---|---|---|---|---|---|---|
| 252,148 | 140,433 | 123,025 | 44.1 | 40.0 | 0.7 | 79.6 | 14.1 |
| $2,118,208,769 | $1,009.855,715 | $533,245,351 | 50.7 | 133.8 | 31.7 | 109.8 | 89.4 |
| (3) | (3) | (3) | [4] 13.9 | ..... | ..... | ..... | ..... |
| (3) | (3) | (3) | 3.1 | ..... | ..... | ..... | ..... |
| 2,053,996 | 1,311,246 | 957,059 | 25.0 | 55.6 | 33.0 | 56.6 | 37.0 |
| $775,584.343 | $378,878,966 | $236,755,464 | 23.1 | 99.5 | 22.2 | 104.7 | 60.0 |
| 1,615,598 | 1,040,349 | 731,137 | 23.7 | 64.8 | 25.0 | 55.3 | 42.3 |
| (3) | (3) | (3) | 21.7 | ..... | ..... | ..... | ..... |
| 323,770 | 270,897 | 225,922 | 28.4 | 51.2 | 64.2 | 19.5 | 19.9 |
| (3) | (3) | (3) | 30.8 | ..... | ..... | ..... | ..... |
| 114,628 | (3) | (3) | 39.5 | [4] 33.6 | 58.7 | ..... | ..... |
| (3) | (3) | (3) | 54.3 | ..... | ..... | ..... | ..... |
| (5) | (5) | (5) | 62.8 | ..... | ..... | ..... | ..... |
| $2,488,427,242 | $1,031,605,092 | $555,123,822 | 42.3 | 52.0 | 36.5 | 141.2 | 85.8 |
| $4,232,325,442 | $1,885,861,676 | $1,019,106,616 | 38.8 | 74.5 | 26.9 | 124.4 | 85.1 |

employees engaged at a fixed compensation per annum, and the wage-earning class, i.e., employees paid by the hour, the day, the week, or the piece, for work performed and only for such work. Prior to 1890 such salaried officials, if returned at all, were returned with the wage-earners proper. At the census of 1890 the number and salaries of proprietors and firm members actively engaged in the business, or in supervision, were reported, combined with clerks and other officials. Where proprietors and firm members were reported without salaries, the amount that would ordinarily be paid for similar services was estimated. At the census of 1900 the number of proprietors and firm members actively engaged in industry or in supervision was ascertained, but no salaries were reported for this class, salaries, as a matter of fact, being rarely paid in such cases, proprietors and firm members depending upon the earnings of the business for their compensation.

3. Employees and Wages.—At the censuses of 1850 and 1860 the inquiries regarding employees and wages called for "the average number of hands employed: male, female," "the average monthly cost of male labor," and "the average monthly cost of female labor." At the census of 1870 the average number of hands employed was called for, divided between "males above 16 years, females above 15 years, and children and youth," and the "total amount paid in wages during the year" was first called for. The inquiries at the census of 1880 were like those of 1870, though more extended for some of the selected industries.

At the census of 1890 the average number of persons employed during the entire year was called for, and also the average number employed at stated weekly rates of pay, and the average number was computed for the actual time the establishments were reported as being in operation. At the census of 1900 the greatest and least numbers of employees were reported and also the average number employed during each month of the year. The average number of wage-earners (men, women, and children) employed during the entire year was computed in the Census Office by using 12, the number of calendar months, as a divisor into the total of the average numbers reported for each month. This difference in the method of ascertain-

ing the average number of wage-earners during the entire year resulted in a variation in the average number as between the two censuses.

Furthermore, the schedules for 1890 included in the wage-earning class "overseers, and foremen or superintendents (not general superintendents or managers)," while the census of 1900 separates from the wage-earning class such salaried employees as general superintendents, clerks, and salesmen. It is probable that this change in the form of the question has resulted in eliminating from the wage-earners, as reported by the present census, many high-salaried employees included in 1890.

4. Miscellaneous Expenses.—This item was not shown at any census prior to that of 1890. Comparison between the totals reported can safely be made between the last two censuses.

5. Materials.—The same statement is true regarding the materials used in manufactures. With the exception of the schedules on which a few selected industries were reported at the census of 1880, the question concerning materials was as follows: "Value of materials used (including mill supplies and fuel)." At the census of 1890 the schedule contained separate questions as to the kind, quantity, and cost of the principal materials, and the cost of "mill supplies," "fuel," and "all other materials." The amounts paid for rent of power and heat were also included under this head in 1890. It is probable that some of the items included the cost of materials at the census of 1880 were included in "miscellaneous expenses" at the inquiries of 1890 and 1900.

6. Products.—These statistics are comparable beginning with the census of 1870.

## COMPARATIVE SUMMARY, BY SPECIFIED INDUSTRIES: 1900.

[Twelfth Census, Vol. VII. page 3, and Vol. VIII. page 18.]

| Industry. | Number of Establishments. | Capital. | Wage-earners. | | Cost of Materials Used. | Value of Products, Including Custom Work and Repairing. |
|---|---|---|---|---|---|---|
| | | | Average Number | Total Wages. | | |
| Total. . . . . | 512,191 | $9,813,834,390 | 5,306,143 | $2,320,938,168 | $7,343,627,875 | $13,000,149,159 |
| Agricultural implements. . . . . | 715 | 157,707,951 | 46,582 | 22,450,880 | 43,944,628 | 101,207,428 |
| Ammunition. . . . . | 33 | 6,719,081 | 5,231 | 2,560,954 | 7,436,748 | 13,027,635 |
| Artificial feathers and flowers. . . . | 227 | 3,633,869 | 5,333 | 1,561,763 | 2,765,151 | 6,297,805 |
| Artificial limbs. . . | 87 | 290,104 | 249 | 146,620 | 126,062 | 749,854 |
| Artists' materials.. | 21 | 376,736 | 200 | 79,267 | 249,107 | 497,046 |
| Awnings, tents, and sails. . . . . | 858 | 4,342,728 | 4,400 | 2,038,613 | 6,480,685 | 11,728,843 |
| Axle grease. . . . . | 29 | 577,195 | 127 | 55,238 | 360,411 | 718,114 |
| Babbitt metal and solder. . . . . | 51 | 3,115,568 | 535 | 294,584 | 7,998,369 | 9,191,409 |
| Bags, other than paper . . . . . | 78 | 7,696,732 | 4,039 | 1,133,128 | 16,849,311 | 20,123,486 |
| Bags, paper. . . . . | 63 | 6,900,291 | 2,029 | 683,783 | 4,659,001 | 7,359,975 |
| Baking and yeast powders. . . . . | 191 | 8,337,723 | 1,938 | 717,000 | 7,126,967 | 14,568,380 |
| Baskets, & rattan and willow ware. | 550 | 2,989,568 | 4,396 | 1,280,511 | 1,398,374 | 3,851,244 |
| Bells. . . . . | 23 | 1,038,305 | 663 | 307,991 | 602,856 | 1,247,730 |
| Belting and hose, leather. . . . . | 105 | 7,410,219 | 1,667 | 913,937 | 7,500,413 | 10,623,177 |
| Belting and hose, linen. . . . . | 7 | 526,059 | 254 | 64,102 | 452,430 | 717,137 |
| Belting and hose, rubber. . . . . | 18 | 5,493,885 | 1,771 | 918,191 | 4,075,702 | 6,169,044 |
| Bicycle and tricycle repairing. . . . | 6,328 | 6,760,070 | 5,749 | 2,505,974 | 5,224,886 | 13,766,033 |
| Bicycles and tricycles. . . . . | 312 | 29,783,659 | 17,525 | 8,189,817 | 16,792,051 | 31,915,908 |
| Billiard tables and materials. . . . . | 75 | 884,901 | 455 | 278,218 | 730,046 | 1,650,868 |
| Blacking. . . . . | 121 | 2,718,504 | 1,250 | 424,174 | 2,186,809 | 4,504,965 |
| Blacksmithing and wheelwrighting. . . . . | 51,771 | 54,976,341 | 36,193 | 17,974,264 | 24,701,632 | 85,971,630 |
| Bluing. . . . . | 65 | 415,119 | 220 | 79,380 | 244,970 | 575,804 |
| Bone, ivory, and lamp black. . . . . | 15 | 782,247 | 85 | 46,107 | 105.712 | 359,787 |

COMPARATIVE SUMMARY, BY SPECIFIED INDUSTRIES: 1900—*Continued.*

| Industry. | Number of Establishments. | Capital. | Wage-earners. | | Cost of Materials Used. | Value of Products, Including Custom Work and Repairing. |
|---|---|---|---|---|---|---|
| | | | Average Number | Total Wages. | | |
| Bookbinding and blank-book making | 954 | $12,744,628 | 15,971 | $6,671,666 | $7,702,543 | $20,790,858 |
| Boot and shoe cut stock | 342 | 7,003,080 | 6,155 | 2,230,691 | 17,800,282 | 23,242,892 |
| Boot and shoe findings | 186 | 3,277,958 | 2,993 | 1,127,784 | 4,627,048 | 7,145,820 |
| Boot and shoe uppers | 132 | 273,796 | 256 | 125,627 | 401,680 | 700,225 |
| Boots and shoes, custom work and repairing | 23,560 | 9,262,134 | 9,698 | 4,128,361 | 8,288,664 | 26,550,678 |
| Boots and shoes, factory product | 1,600 | 101,795,233 | 142,922 | 59,175,883 | 169,604,054 | 261,028,580 |
| Boots and shoes, rubber | 22 | 33,667,533 | 14,391 | 6,426,579 | 22,682,543 | 41,089,819 |
| Bottling | 2,064 | 16,620,152 | 7,680 | 3,589,447 | 28,087,823 | 41,640,672 |
| Boxes, cigar | 315 | 3,288,272 | 4,609 | 1,439,599 | 3,061,193 | 5,856,915 |
| Boxes, fancy and paper | 729 | 14,979,305 | 27,653 | 8,151,625 | 11,765,424 | 27,316,317 |
| Boxes, wooden packing | 896 | 21,952,757 | 22,034 | 7,827,955 | 22,807,627 | 38,216,384 |
| Brass | 10 | 503,367 | 162 | 98,796 | 1,152,635 | 1,419,817 |
| Brass and copper, rolled | 19 | 15,629,766 | 6,759 | 3,512,781 | 30,000,632 | 37,536,325 |
| Brass castings and brass finishing | 442 | 21,925,039 | 11,964 | 6,070,762 | 18,871,141 | 30,343,044 |
| Brassware | 204 | 12,194,715 | 7,668 | 3,550,074 | 9,830,319 | 17,140,075 |
| Bread and other bakery products | 14,917 | 81,049,553 | 60,271 | 27,893,170 | 95,221,915 | 175,657,348 |
| Brick and tile | 5,423 | 82,036,438 | 61,979 | 21,883,333 | 11,006,148 | 51,270,476 |
| Bridges | 196 | 16,768,948 | 12,181 | 6,711,260 | 16,258,561 | 30,151,624 |
| Bronze castings | 21 | 881,769 | 621 | 372,797 | 1,339,722 | 2,229,329 |
| Brooms and brushes | 1,526 | 9,616,780 | 10,349 | 3,788,046 | 9,546,854 | 18,490,847 |
| Butter, rework'g | 10 | 255,525 | 148 | 67,747 | 1,345,418 | 2,114,935 |
| Buttons | 238 | 4,212,568 | 8,685 | 2,826,238 | 2,803,246 | 7,695,910 |
| Calcium lights | 19 | 95,114 | 55 | 24,418 | 34,982 | 118,666 |
| Cardboard | 5 | 1,168,495 | 626 | 264,427 | 705,527 | 1,270,416 |
| Card cutting and designing | 43 | 337,642 | 325 | 135,139 | 312,760 | 618,488 |
| Carpentering | 21,315 | 71,327,047 | 123,985 | 71,049,737 | 142,419,410 | 316,101,758 |
| Carpets and rugs, other than rag | 133 | 44,449,299 | 28,411 | 11,121,383 | 27,228,719 | 48,192,351 |
| Carpets, rag | 1,014 | 975,190 | 1,504 | 492,656 | 681,311 | 1,993,756 |
| Carpets, wood | 31 | 412,357 | 608 | 362,112 | 418,343 | 1,056,702 |
| Carriage and wagon materials | 588 | 19,085,775 | 15,387 | 5,987,267 | 13,048,608 | 25,027,173 |
| Carriages and sleds, children's | 77 | 2,906,472 | 2,726 | 1,090,296 | 1,996,070 | 4,289,695 |
| Carriages and wagons | 7,632 | 118,187,838 | 62,540 | 29,814,911 | 56,676,073 | 121,537,276 |
| Cars and general shop construc'n and repairs by steam railroad companies | 1,295 | 119,473,042 | 173,595 | 96,006,570 | 109,472,353 | 218,113,658 |
| Cars, railroad and street, and repairs, not including establishments operated by steam railroad companies | 193 | 106,721,188 | 44,063 | 23,342,763 | 70,046,354 | 107,186,359 |
| Celluloid and celluloid goods (1890) | 12 | 3,158,487 | 939 | 447,120 | 856,180 | 2,575,736 |
| Charcoal | 183 | 811,225 | 1,786 | 431,381 | 405,339 | 1,133,638 |

COMPARATIVE SUMMARY, BY SPECIFIED INDUSTRIES: 1900—*Continued.*

| Industry. | Number of Establishments. | Capital. | Wage-earners. | | Cost of Materials Used. | Value of Products, Including Custom Work and Repairing. |
|---|---|---|---|---|---|---|
| | | | Average Number. | Total Wages. | | |
| Cheese, butter, and condensed milk | 9,355 | $36,508,015 | 12,865 | $6,170,670 | $109,151,205 | $131,199,277 |
| Chemicals | 459 | 89,091,430 | 19,054 | 9,401,467 | 34,564,137 | 62,676,730 |
| China decorating | 169 | 372,017 | 360 | 148,004 | 261,819 | 693,800 |
| Chocolate and cocoa products | 24 | 6,890,732 | 1,314 | 525,875 | 6,876,682 | 9,666,192 |
| Cleansing and polishing preparations | 154 | 943,328 | 508 | 209,438 | 965,242 | 2,193,019 |
| Clocks | 46 | 8,792,653 | 6,037 | 2,650,703 | 3,028,606 | 7,157,856 |
| Cloth, sponging and refinishing | 46 | 288,894 | 534 | 268,191 | 17,490 | 566,000 |
| Clothing, horse | 26 | 653,545 | 575 | 176,687 | 847,846 | 1,305,164 |
| Clothing, men's | 28,014 | 173,034,543 | 191,043 | 79,434,932 | 197,742,067 | 415,256,391 |
| Clothing, women's dressmaking | 14,479 | 13,815,221 | 45,595 | 14,352,453 | 16,503,754 | 48,356,034 |
| Clothing, wom'n's, factory product | 2,701 | 48,431,544 | 83,739 | 32,586,101 | 84,704,592 | 159,339,539 |
| Coffee and spice, roasting and grinding | 458 | 28,436,897 | 6,387 | 2,486,759 | 55,112,203 | 69,527,108 |
| Coffins, burial cases, and undertakers' goods | 217 | 13,585,162 | 6,840 | 3,077,481 | 6,945,348 | 13,952,308 |
| Coke | 241 | 36,502,679 | 16,999 | 7,085,736 | 19,665,532 | 35,585,445 |
| Collars and cuffs, paper (1890) | 3 | 237,764 | 82 | 35,125 | 223,077 | 301,093 |
| Combs | 34 | 832,791 | 1,399 | 572,467 | 951,514 | 1,976,129 |
| Confectionery | 4,297 | 35,155,361 | 33,583 | 10,867,687 | 45,534,153 | 81,290,543 |
| Cooperage | 2,146 | 22,568,873 | 22,938 | 9,200,303 | 23,299,312 | 40,576,462 |
| Copper, smelting and refining | 47 | 53,063,395 | 11,324 | 8,529,021 | 122,174,129 | 165,131,670 |
| Cordage and twine | 105 | 29,275,470 | 13,114 | 4,113,112 | 26,632,006 | 37,849,651 |
| Cordials & syrups | 39 | 1,153,006 | 362 | 116,917 | 1,505,096 | 2,107,132 |
| Cork, cutting | 62 | 2,683,683 | 2,340 | 687,796 | 2,403,829 | 4,392,364 |
| Corsets | 216 | 7,481,048 | 12,729 | 3,791,509 | 6,555,467 | 14,878,116 |
| Cotton, compressing | 111 | 8,323,558 | 2,742 | 738,288 | 353,910 | 2,629,590 |
| Cotton, ginning | 11,369 | 23,228,130 | 14,135 | 1,930,039 | 3,912,303 | 14,748,270 |
| Cotton goods | 1,055 | 467,240,157 | 302,861 | 86,689,752 | 176,551,527 | 339,200,320 |
| Cotton waste | 26 | 2,560,759 | 1,116 | 336,827 | 4,950,490 | 5,880,024 |
| Crucibles | 11 | 1,843,616 | 671 | 250,654 | 1,673,290 | 2,607,308 |
| Cutlery and edge tools | 309 | 16,532,383 | 12,069 | 5,673,619 | 5,116,042 | 14,881,478 |
| Dentistry, Mechanical (1890) | 3,214 | 4,019,637 | 1,486 | 768,401 | 1,475,255 | 7,864,299 |
| Dentists' materi'ls | 68 | 2,112,236 | 1,017 | 508,603 | 2,109,231 | 3,721,150 |
| Druggists' preparations, not including prescriptions | 250 | 16,320,120 | 5,766 | 2,041,061 | 11,022,417 | 23,192,785 |
| Drug grinding | 26 | 2,837,911 | 644 | 291,823 | 3,315,228 | 4,308,144 |
| Dyeing and cleaning | 1,810 | 4,673,211 | 5,424 | 2,271,066 | 1,434,292 | 7,567,358 |
| Dyeing and finishing textiles | 298 | 60,643,104 | 29,776 | 12,726,316 | 17,958,137 | 44,963,331 |
| Dye stuffs and extracts | 77 | 7,839,034 | 1,647 | 787,942 | 4,745,912 | 7,350,748 |
| Electrical apparatus and supplies | 580 | 83,130,943 | 40,890 | 20,190,344 | 48,916,440 | 91,348,889 |
| Electrical construction and repairs | 1,162 | 5,438,087 | 5,949 | 3,312,126 | 7,673,507 | 15,907,420 |
| Electroplating | 422 | 1,460,692 | 2,275 | 1,036,750 | 836,726 | 3,007,455 |
| Emery wheels | 34 | 1,489,527 | 546 | 303,091 | 508,753 | 1,381,675 |
| Enameling and enameled goods | 129 | 9,184,178 | 7,675 | 2,259,003 | 5,466,971 | 9,978,509 |

COMPARATIVE SUMMARY, BY SPECIFIED INDUSTRIES: 1900—*Continued.*

| Industry. | Number of Establishments. | Capital. | Wage-earners. | | Cost of Materials Used. | Value of Products, Including Custom Work and Repairing. |
|---|---|---|---|---|---|---|
| | | | Average Number. | Total Wages. | | |
| Engravers' materials | 12 | $104,741 | 79 | $46,064 | $143,270 | $289,339 |
| Engraving and die-sinking | 414 | 790,461 | 1,034 | 572,874 | 225,637 | 1,683,690 |
| Engraving, steel, including plate printing | 286 | 5,061,520 | 3,299 | 2,006,824 | 1,206,462 | 5,068,558 |
| Engraving, wood | 145 | 231,817 | 337 | 206,537 | 63,272 | 616,166 |
| Envelopes | 51 | 5,612,509 | 2,984 | 1,150,463 | 3,665,275 | 6,299,330 |
| Explosives | 97 | 19,465,846 | 4,502 | 2,383,756 | 10,334,974 | 17,125,418 |
| Fancy articles, not elsewhere specified | 392 | 5,081,806 | 5,718 | 1,921,578 | 4,061,400 | 9,046,342 |
| Felt goods | 36 | 7,125,276 | 2,688 | 1,024,835 | 3,801,028 | 6,461,691 |
| Fertilizers | 422 | 60,685,753 | 11,581 | 4,185,289 | 28,958,473 | 44,657,385 |
| Files | 86 | 3,857,647 | 3,160 | 1,277,199 | 1,166,414 | 3,403,906 |
| Firearms | 32 | 6,916,231 | 4,482 | 2,542,366 | 1,305,421 | 5,444,659 |
| Fire extinguishers, chemical | 17 | 136,933 | 64 | 32,828 | 70,874 | 217,833 |
| Fireworks | 46 | 1,086,133 | 1,638 | 506,990 | 627,761 | 1,785,271 |
| Fish, canning and preserving | 312 | 16,310,987 | 11,318 | 2,986,996 | 11,644,118 | 18,432,613 |
| Flags and banners | 36 | 666,033 | 509 | 148,933 | 547,165 | 1,038,052 |
| Flavoring extracts | 352 | 3,319,716 | 1,254 | 478,975 | 3,294,380 | 6,314,552 |
| Flax, dressed | 4 | 71,496 | 211 | 46,000 | 91,032 | 158,650 |
| Flouring and grist mill products | 25,258 | 218,714,104 | 37,073 | 17,703,418 | 475,826,345 | 560,719,063 |
| Food preparations | 644 | 20,998,102 | 8,154 | 3,051,718 | 23,675,165 | 38,457,651 |
| Foundry and machine shop products | 9,324 | 665,038,245 | 350,327 | 182,232,009 | 286,357,107 | 644,990,999 |
| Foundry supplies | 30 | 981,817 | 278 | 135,877 | 628,160 | 1,128,856 |
| Fruits and vegetables, canning and preserving | 1,808 | 27,743,067 | 36,401 | 8,050,793 | 37,524,297 | 56,668,313 |
| Fur goods | 994 | 13,373,867 | 8,588 | 4,273,192 | 15,113,365 | 27,735,264 |
| Furnishing goods, men's | 470 | 20,163,222 | 30,216 | 9,680,077 | 23,404,969 | 43,902,162 |
| Furniture, including cabinetmaking, repairing, & upholstering | 7,972 | 117,982,091 | 100,018 | 42,638,810 | 65,499,877 | 153,168,309 |
| Furs, dressed | 92 | 798,030 | 835 | 478,190 | 519,699 | 1,400,455 |
| Galvanizing | 28 | 1,775,770 | 535 | 229,406 | 1,677,584 | 2,470,703 |
| Gas and lamp fixtures | 223 | 10,009,239 | 7,642 | 3,504,301 | 5,013,597 | 12,577,806 |
| Gas and oil stoves | 35 | 3,766,065 | 2,471 | 1,138,442 | 2,501,568 | 4,579,700 |
| Gas, illuminating and heating | 877 | 567,000,506 | 22,459 | 12,436,296 | 20,605,356 | 75,716,693 |
| Gas machines and meters | 114 | 4,605,624 | 2,167 | 1,185,959 | 1,943,769 | 4,392,730 |
| Glass | 355 | 61,423,903 | 52,818 | 27,084,710 | 16,731,009 | 56,539,712 |
| Glass, cutting, staining, and ornamenting | 417 | 4,013,534 | 4,931 | 2,403,591 | 3,540,097 | 8,776,006 |
| Gloves and mittens | 394 | 9,089,809 | 14,345 | 4,182,518 | 9,483,130 | 16,926,156 |
| Glucose | 8 | 41,011,345 | 3,288 | 1,755,179 | 15,773,233 | 21,693,656 |
| Glue | 61 | 6,144,407 | 1,618 | 685,096 | 3,767,023 | 5,389,006 |
| Gold and silver, leaf and foil | 93 | 1,086,854 | 1,163 | 498,692 | 1,604,013 | 2,666,224 |
| Gold and silver, reducing and refining, not from the ore | 57 | 1,944,124 | 219 | 141,400 | 10,932,361 | 11,811,537 |
| Graphite and graphite refining | 11 | 411,128 | 137 | 64,376 | 216,560 | 429,173 |

COMPARATIVE SUMMARY, BY SPECIFIED INDUSTRIES: 1900—*Continued.*

| Industry. | Number of Establishments. | Capital. | Wage-earners. | | Cost of Materials Used. | Value of Products, Including Custom Work and Repairing. |
|---|---|---|---|---|---|---|
| | | | Average Number. | Total Wages. | | |
| Grease and tallow. | 289 | $7,080,692 | 2,046 | $1,069,683 | $8,761,857 | $11,969,821 |
| Grindstones. | 25 | 903,348 | 1,167 | 407,153 | 263,811 | 1,088,909 |
| Hairwork. | 397 | 1,009,908 | 1,101 | 375,156 | 673,004 | 1,952,792 |
| Hammocks. | 13 | 308,254 | 339 | 101,626 | 242,950 | 480,114 |
| Hand knit goods. | 86 | 205,488 | 304 | 75,870 | 124,009 | 352,226 |
| Hand stamps. | 268 | 1,203,910 | 1,052 | 490,036 | 522,659 | 1,937,628 |
| Hardware. | 381 | 39,311,745 | 26,463 | 11,422,758 | 14,605,244 | 35,846,656 |
| Hardware, saddlery. | 80 | 3,335,274 | 2,940 | 1,217,202 | 1,690,168 | 4,149,489 |
| Hat and cap materials. | 70 | 1,744,419 | 1,371 | 434,148 | 2,797,756 | 3,849,116 |
| Hats and caps, not including wool hats. | 816 | 25,095,798 | 31,425 | 14,144,552 | 24,421,052 | 49,205,667 |
| Hones and whetstones. | 18 | 216,836 | 189 | 72,879 | 64,278 | 196,323 |
| Hooks and eyes. | 9 | 1,382,394 | 300 | 127,518 | 255,427 | 499,543 |
| Horseshoes, factory product. | 6 | 344,151 | 167 | 90,527 | 172,237 | 387,619 |
| Hosiery and knit goods. | 921 | 81,860,604 | 83,387 | 24,358,627 | 51,071,859 | 95,482,566 |
| House furnishing goods, not elsewhere specified. | 210 | 10,638,248 | 5,212 | 1,837,552 | 9,198,803 | 14,280,575 |
| Ice, manufact'd. | 775 | 38,019,507 | 6,880 | 3,402,745 | 3,312,393 | 13,780,978 |
| Ink. | 104 | 3,821,514 | 787 | 412,140 | 2,109,142 | 4,372,707 |
| Instruments, professional and scientific. | 265 | 4,491,627 | 2,786 | 1,433,715 | 1,385,292 | 4,896,631 |
| Iron and steel. | 668 | 573,391,663 | 222,490 | 120,820,276 | 522,398,932 | 803,968,273 |
| Iron and steel, bolts, nuts, washers, and rivets. | 72 | 10,799,692 | 7,660 | 2,991,857 | 8,071,071 | 13,978,382 |
| Iron and steel, doors and shutters. | 13 | 261,958 | 117 | 85,683 | 115,718 | 319,629 |
| Iron and steel, forgings. | 91 | 9,677,193 | 4,688 | 2,559,433 | 5,213,550 | 10,439,742 |
| Iron and steel, nails and spikes, cut and wrought, including wire nails. | 102 | 10,751,359 | 4,477 | 2,042,250 | 8,561,571 | 14,777,299 |
| Iron and steel, pipe, wrought. | 19 | 18,343,977 | 5,536 | 2,495,898 | 15,523,858 | 21,292,043 |
| Ironwork, architectural and ornamental. | 672 | 33,062,409 | 20,646 | 11,111,226 | 31,140,636 | 53,508,179 |
| Ivory and bone work. | 70 | 939,714 | 1,334 | 529,051 | 930,224 | 1,873,357 |
| Japanning. | 38 | 117,639 | 160 | 75,453 | 55,305 | 215,506 |
| Jewelry. | 908 | 28,120,939 | 20,676 | 10,746,375 | 22,356,067 | 46,501,181 |
| Jewelry and instrument cases. | 63 | 547,753 | 819 | 322,566 | 435,717 | 1,156,977 |
| Jute and jute goods. | 18 | 7,027,293 | 4,506 | 1,181,790 | 3,015,362 | 5,383,797 |
| Kaolin and other earth grinding. | 145 | 12,212,341 | 2,094 | 820,678 | 1,651,335 | 3,722,151 |
| Kindling wood. | 85 | 1,775,272 | 1,525 | 566,635 | 735,844 | 1,784,690 |
| Labels and tags. | 47 | 848,115 | 754 | 289,273 | 337,517 | 1,104,652 |
| Lamps and reflectors. | 156 | 6,375,474 | 4,725 | 2,076,980 | 3,497,236 | 8,341,374 |
| Lapidary work. | 60 | 3,037,390 | 498 | 498,715 | 4,655,765 | 5,786,281 |
| Lard, refined. | 19 | 1,335,759 | 499 | 237,930 | 7,496,845 | 8,630,901 |
| Lasts. | 65 | 1,484,966 | 1,131 | 649,654 | 526,670 | 1,879,742 |
| Lead, bar, pipe, and sheet. | 34 | 3,949,330 | 605 | 321,598 | 6,279,497 | 7,477,824 |

COMPARATIVE SUMMARY, BY SPECIFIED INDUSTRIES: 1900—*Continued.*

| Industry. | Number of Establishments. | Capital. | Wage-earners. | | Cost of Materials Used. | Value of Products, Including Custom Work and Repairing. |
|---|---|---|---|---|---|---|
| | | | Average Number. | Total Wages. | | |
| Lead, smelting and refining | 39 | $72,148,933 | 8,319 | $5,088,684 | $144,195,163 | $175,466,304 |
| Leather board | 3 | 49,500 | 71 | 24,350 | 49,451 | 108,734 |
| Leather goods | 313 | 5,467,294 | 6,253 | 2,256,280 | 6,162,148 | 11,717,401 |
| Leather, tanned, curried, and finished | 1,306 | 173,977,421 | 52,109 | 22,591,091 | 155,000,004 | 204,038,127 |
| Lime and cement | 1,000 | 48,833,730 | 19,107 | 7,749,815 | 11,041,577 | 28,689,135 |
| Linen goods | 18 | 5,688,999 | 3,283 | 1,036,839 | 2,550,517 | 4,368,159 |
| Liquors, distilled | 967 | 32,551,604 | 3,722 | 1,733,218 | 15,147,784 | 96,798,443 |
| Liquors, malt | 1,509 | 415,284,468 | 39,532 | 25,826,211 | 51,674,928 | 237,269,713 |
| Liquors, vinous | 359 | 9,838,015 | 1,163 | 446,055 | 3,689,330 | 6,547,310 |
| Lithographing and engraving | 263 | 22,676,142 | 12,994 | 6,882,168 | 7 886,045 | 22,240,679 |
| Lock and gunsmithing | 2,103 | 2,250,300 | 1,553 | 769,351 | 929,700 | 3,703,127 |
| Looking-glass and picture frames | 1,629 | 7,747,382 | 7,712 | 3,370,072 | 6,887,331 | 15,570,293 |
| Lumber and timber products | 33,010 | 611,429,574 | 283,179 | 104,563,603 | 317,832,865 | 566,621,755 |
| Lumber, planing mill products, including sash, doors, and blinds | 4,204 | 119,271,631 | 73,627 | 32,685,210 | 99,927,707 | 168,343,003 |
| Malt | 146 | 39,288,102 | 1,990 | 1,182,513 | 14,816,741 | 19,373,600 |
| Mantels, slate, marble, and marbleized | 36 | 811,995 | 449 | 291,050 | 487,965 | 1,153,540 |
| Marble and stone work | 6,070 | 67,509,533 | 54,370 | 28,663,241 | 30,443,297 | 85,101,591 |
| Masonry, brick and stone | 8,333 | 48,070,239 | 93,568 | 53,152,258 | 87,280,964 | 203,593,634 |
| Matches | 22 | 3,893,000 | 2,047 | 612,715 | 3,420,740 | 6,005,937 |
| Mats and matting | 9 | 994,155 | 1,197 | 237,282 | 516,137 | 1,165,330 |
| Mattresses and spring beds | 797 | 8,298,772 | 7,959 | 3,213,268 | 10,444,009 | 18,463,704 |
| Millinery and lace goods | 591 | 10,764,813 | 16,871 | 5,817,855 | 15,654,295 | 29,469,406 |
| Millinery, custom work | 16,151 | 27,740,386 | 33,298 | 9,570,536 | 36,455,043 | 70,363,752 |
| Millstones | 3 | 49,238 | 37 | 20,957 | 30,995 | 75,922 |
| Mineral and soda waters | 2,816 | 20,518,708 | 8,985 | 4,169,113 | 8,801,467 | 23,874,429 |
| Mirrors | 103 | 3,184,426 | 2,555 | 1,231,689 | 4,995,671 | 8,004,301 |
| Models and patterns | 532 | 2,250,484 | 2,608 | 1,565,728 | 825,111 | 3,836,518 |
| Mucilage & paste | 117 | 1,265,426 | 480 | 205,082 | 1,657,342 | 2,629,299 |
| Musical instruments and materials, not specified | 229 | 3,896,101 | 2,405 | 1,232,039 | 1,205,337 | 3,394,734 |
| Musical instruments, organs, and materials | 129 | 5,011,987 | 3,435 | 1,720,727 | 2,220,165 | 5,691,504 |
| Musical instruments, pianos and materials | 261 | 38,790,494 | 17,869 | 9,818,996 | 15,147,520 | 35,324,090 |
| Needles and pins | 43 | 3,235,158 | 2,353 | 939,846 | 972,570 | 2,738,439 |
| Nets and seines | 19 | 1,160,782 | 748 | 222,146 | 865,908 | 1,476,022 |
| Oakum | 7 | 416,199 | 171 | 51,343 | 283,862 | 440,237 |
| Oil, castor | 3 | 539,221 | 49 | 29,068 | 293,408 | 395,400 |
| Oil, cotton seed and cake | 369 | 34,451,461 | 11,007 | 3,143,459 | 45,165,823 | 58,726,632 |
| Oil, essential | 70 | 612,657 | 199 | 69,100 | 596,112 | 850,093 |
| Oil, lard | 7 | 369,773 | 78 | 42,205 | 971,647 | 1,221,841 |
| Oil, linseed | 48 | 15,460,512 | 1,328 | 693,311 | 24,395,775 | 27,184,331 |
| Oil, not elsewhere specified | 193 | 9,441,984 | 1,353 | 679,730 | 9,807,859 | 17,089,799 |

COMPARATIVE SUMMARY, BY SPECIFIED INDUSTRIES: 1900—*Continued.*

| Industry. | Number of Establishments. | Capital. | Wage-earners. | | Cost of Materials Used. | Value of Products, Including Custom Work and Repairing. |
|---|---|---|---|---|---|---|
| | | | Average Number. | Total Wages. | | |
| Oil, resin | 8 | $284,110 | 90 | $53,596 | $535,320 | $738,680 |
| Oilcloth, enamel'd | 9 | 1,702,904 | 512 | 300,878 | 2,696,412 | 3,595,515 |
| Oilcloth, floor | 18 | 7,176,198 | 2,718 | 1,327,235 | 4,853,260 | 7,807,105 |
| Oleomargarine | 24 | 3,023,646 | 1,084 | 534,444 | 7,639,501 | 12,499,812 |
| Optical goods | 350 | 5,567,809 | 4,341 | 1,935,219 | 3,233,430 | 7,790,970 |
| Ordnance and ordnance stores | 4 | 3,468,713 | 989 | 615,280 | 802,706 | 2,239,797 |
| Oysters, canning and preserving | 39 | 1,240,696 | 2,779 | 630,016 | 2,608,757 | 3,670,134 |
| Painting and paper hanging | 16,939 | 27,217,086 | 59,191 | 34,822,819 | 26,304,784 | 88,396,852 |
| Paints | 419 | 42,501,782 | 8,151 | 3,929,787 | 33,799,386 | 50,874,995 |
| Paper and wood pulp | 763 | 167,507,713 | 49,646 | 20,746,426 | 70,530,236 | 127,326,162 |
| Paper goods, not elsewhere specified | 190 | 11,370,585 | 6,117 | 2,242,702 | 9,819,820 | 16,785,269 |
| Paper hangings | 51 | 8,889,794 | 4,172 | 2,074,138 | 6,072,809 | 10,663,209 |
| Paper patterns | 16 | 256,075 | 836 | 262,559 | 124,854 | 563,653 |
| Patent medicines and compounds | 2,026 | 37,209,793 | 11,809 | 4,407,988 | 18,185,513 | 59,611,335 |
| Paving and paving materials | 1,729 | 37,888,412 | 34,090 | 14,570,408 | 20,152,477 | 46,447,719 |
| Pencils, lead | 7 | 2,227,406 | 2,162 | 683,281 | 1,030,917 | 2,222,276 |
| Pens, fountain and stylographic | 23 | 590,629 | 318 | 141,012 | 351,932 | 906,454 |
| Pens, gold | 22 | 496,246 | 378 | 229,679 | 312,537 | 799,078 |
| Pens, steel | 3 | 357,460 | 473 | 138,433 | 52,466 | 294,340 |
| Perfumery and cosmetics | 266 | 3,499,168 | 1,768 | 569,286 | 3,136,853 | 7,095,713 |
| Petroleum refining | 67 | 95,327,892 | 12,199 | 6,717,087 | 102,859,341 | 123,929,384 |
| Phonographs and graphophones | 11 | 3,348,282 | 1,267 | 608,490 | 827,529 | 2,246,274 |
| Photographic apparatus | 48 | 1,849,724 | 1,961 | 779,890 | 595,925 | 2,026,063 |
| Photographic materials | 105 | 3,668,026 | 1,483 | 662,958 | 2,782,285 | 5,773,325 |
| Photography | 7,553 | 13,193,589 | 8,911 | 4,013,018 | 6,841,853 | 23,238,719 |
| Photolithographing and photoengraving | 204 | 1,999,921 | 2,698 | 1,756,578 | 728,743 | 4,226,106 |
| Pickles, preserves, and sauces | 474 | 10,656,854 | 6,812 | 2,161,962 | 12,422,432 | 21,507,046 |
| Pipes, tobacco | 98 | 1,111,144 | 1,585 | 737,647 | 1,106,299 | 2,471,908 |
| Plated and britannia ware | 66 | 16,486,471 | 6,392 | 3,088,224 | 5,875,312 | 12,608,770 |
| Plumbers' supplies | 174 | 13,598,528 | 8,024 | 3,930,594 | 7,289,867 | 14,771,185 |
| Plumbing and gas and steam fitt'g | 11,876 | 47,111,264 | 53,916 | 31,873,866 | 65,334,689 | 131,852,567 |
| Pocketbooks | 68 | 991,876 | 1,653 | 588,595 | 1,278,226 | 2,495,188 |
| Pottery, terra cotta, and fire-clay products | 1,000 | 65,951,885 | 43,714 | 17,691,737 | 11,915,236 | 44,263,386 |
| Printing and publishing | 22,312 | 292,517,072 | 162,992 | 84,249,954 | 86,856,290 | 347,055 050 |
| Printing materials | 70 | 905,603 | 560 | 232,799 | 406,357 | 1,088,432 |
| Pulp, from fiber other than wood | 3 | 479,158 | 121 | 28,462 | 42,204 | 103,204 |
| Pulp goods | 22 | 2,316,985 | 691 | 283,835 | 646,639 | 1,267,013 |
| Pumps, not including steam pumps | 130 | 1,260,710 | 632 | 247,193 | 637,768 | 1,341.713 |
| Refrigerators | 95 | 4,782,110 | 3,329 | 1,287,488 | 2,476,518 | 5,317,886 |
| Regalia and society banners and emblems | 120 | 1,795,858 | 1,586 | 476,580 | 1,608,415 | 3,077,945 |
| Registers, car fare | 5 | 104,408 | 52 | 25,775 | 17,403 | 80,865 |

COMPARATIVE SUMMARY, BY SPECIFIED INDUSTRIES: 1900—*Continued.*

| Industry. | Number of Establishments. | Capital. | Wage-earners. | | Cost of materials Used. | Value of Products, Including Custom Work and Repairing. |
|---|---|---|---|---|---|---|
| | | | Average Number. | Total Wages. | | |
| Registers, cash | 13 | $5,137,965 | 2,015 | $1,223,966 | $903,834 | $5,594,500 |
| Rice, cleaning and polishing | 80 | 2,601,352 | 651 | 265,585 | 7,575,522 | 8,723,726 |
| Roofing and roofing materials | 2,162 | 17,594,162 | 15,362 | 6,996,810 | 14,624,759 | 29,916,592 |
| Rubber and elastic goods | 262 | 39,304,853 | 20,405 | 8,082,738 | 33,485,694 | 52,627,030 |
| Rules, ivory and wood | 11 | 202,724 | 213 | 66,732 | 72,657 | 207,757 |
| Saddlery and harness | 12,934 | 43,354,136 | 24,123 | 10,725,647 | 33,127,926 | 62,630,902 |
| Safes and vaults | 35 | 5,479,879 | 2,033 | 1,017,237 | 1,689,148 | 3,927,867 |
| Salt | 159 | 27,123,364 | 4,774 | 1,911,140 | 3,335,922 | 7,966,897 |
| Sand and emery paper and cloth | 9 | 1,372,307 | 274 | 144,183 | 681,240 | 1,175,895 |
| Saws | 96 | 8,508,487 | 3,215 | 1,692,757 | 2,600,217 | 6,443,748 |
| Scales and balances | 86 | 6,307,576 | 2,775 | 1,436,839 | 1,533,379 | 5,239,788 |
| Screws | 33 | 7,931,457 | 3,527 | 1,423,838 | 1,720,455 | 4,658,467 |
| Sewing machine cases | 7 | 1,333,341 | 2,653 | 1,065,180 | 1,533,880 | 2,815,142 |
| Sewing machine repairing | 396 | 331,433 | 310 | 154,036 | 220,537 | 710,123 |
| Sewing machines and attachments | 58 | 18,739,459 | 10,635 | 6,213,938 | 7,809,796 | 18,314,419 |
| Shipbuilding | 1,116 | 77,362,701 | 46,781 | 24,839,163 | 33,486,772 | 74,578,158 |
| Shirts | 986 | 20,312,412 | 38,492 | 11,425,101 | 23,662,317 | 49,022,845 |
| Shoddy | 105 | 5,272,929 | 1,926 | 748,948 | 4,875,192 | 6,730,974 |
| Show cases | 102 | 1,152,898 | 1,363 | 708,211 | 1,057,666 | 2,467,901 |
| Silk and silk goods | 483 | 81,082,201 | 65,416 | 20,982,194 | 62,406,665 | 107,256,258 |
| Silversmithing | 44 | 1,999,921 | 1,437 | 803,662 | 1,229,158 | 2,936,462 |
| Silverware | 59 | 12,142,008 | 4,376 | 2,639,480 | 4,554,487 | 10,569,121 |
| Slaughtering and meat packing, not including retail butchering | 1,134 | 190,706,927 | 69,441 | 33,923,253 | 686,860,891 | 790,252,586 |
| Smelting and refining, not from the ore | 61 | 5,200,523 | 983 | 532,068 | 5,899,935 | 7,784,695 |
| Soap and candles | 558 | 38,068,334 | 9,487 | 3,754,767 | 33,143,230 | 53,231,017 |
| Soda water apparatus | 30 | 4,202,452 | 963 | 549,939 | 997,436 | 3,015,493 |
| Sporting goods | 144 | 2,018,737 | 2,230 | 810,943 | 1,802,903 | 3,633,396 |
| Springs, steel, car and carriage | 48 | 4,684,278 | 2,102 | 1,061,006 | 3,024,656 | 5,690,499 |
| Stamped ware | 139 | 13,954,176 | 10,002 | 3,730,241 | 7,333,028 | 14,546,191 |
| Starch | 124 | 11,671,567 | 2,655 | 1,099,696 | 5,806,422 | 9,232,984 |
| Stationery goods, not elsewhere specified | 113 | 4,494,507 | 3,032 | 958,471 | 2,128,445 | 5,065,869 |
| Steam fittings and heating apparatus | 227 | 18,233,173 | 9,252 | 4,982,857 | 10,219,506 | 22,084,860 |
| Steam packing | 97 | 2,691,304 | 1,147 | 525,332 | 1,546,398 | 3,493,710 |
| Stencils and brands | 92 | 532,528 | 418 | 206,231 | 140,711 | 673,784 |
| Stereotyping and electrotyping | 140 | 2,389,215 | 2,408 | 1,458,977 | 766,603 | 3,772,025 |
| Straw goods, not elsewhere specified | 4 | 25,070 | 54 | 14,381 | 12,933 | 36,985 |
| Sugar and molasses, beet | 30 | 20,141,719 | 1,970 | 1,092,207 | 4,803,796 | 7,323,857 |
| Sugar and molasses, refining | 832 | 184,245,519 | 14,262 | 6,945,811 | 222,503,741 | 240,969,905 |
| Surgical appliance's | 219 | 2,487,494 | 1,539 | 620,801 | 1,291,580 | 3,932,358 |
| Taxidermy | 147 | 366,077 | 180 | 91,140 | 177,038 | 513,112 |
| Tin and terneplate | 57 | 6,650,047 | 3,671 | 1,889,917 | 26,728,150 | 31,892,011 |

COMPARATIVE SUMMARY, BY SPECIFIED INDUSTRIES: 1900—*Continued.*

| Industry. | Number of Establishments. | Capital. | Wage-earners. | | Cost of Materials Used. | Value of products, Including Custom Work and Repairing. |
|---|---|---|---|---|---|---|
| | | | Average Number. | Total Wages. | | |
| Tinfoil | 15 | $2,094,327 | 582 | $227,774 | $1,074,192 | $1,593,169 |
| Tinsmithing, coppersmithing, and sheet-iron working | 12,466 | 55,703,509 | 45,575 | 22,155,039 | 50,329,282 | 100,310,720 |
| Tobacco, chewing, smoking, and snuff | 437 | 43,856,570 | 29,161 | 7,109,821 | 35,038,287 | 103,754,362 |
| Tobacco, cigars and cigarettes | 14,539 | 67,706,493 | 103,462 | 40,925,596 | 57,946,020 | 160,223,152 |
| Tobacco, stemming and rehandling | 276 | 12,526,808 | 9,654 | 1,817,067 | 14,198,349 | 19,099,032 |
| Tools, not elsewhere specified | 448 | 13,690,047 | 7,615 | 3,781,763 | 4,657,200 | 13,360,920 |
| Toys and games | 170 | 3,289,445 | 3,330 | 1,123,593 | 1,668,199 | 4,024,999 |
| Trunks and valises | 391 | 7,046,649 | 7,084 | 2,834,892 | 6,045,387 | 12,693,225 |
| Turpentine and rosin | 1,503 | 11,847,495 | 41,864 | 8,303,483 | 6,186,492 | 20,344,888 |
| Type founding | 22 | 2,269,370 | 1,424 | 803,470 | 863,689 | 2,842,384 |
| Typewriter repairing | 85 | 134,123 | 185 | 116,220 | 110,603 | 367,176 |
| Typewriters and supplies | 47 | 8,400,431 | 4,340 | 2,403,604 | 1,402,170 | 6,932,029 |
| Umbrellas and canes | 261 | 4,677,917 | 5,695 | 1,889,673 | 8,457,167 | 13,855,908 |
| Upholstering materials | 270 | 7,593,598 | 5,098 | 1,715,073 | 5,881,621 | 10,048,164 |
| Varnish | 181 | 17,550,892 | 1,546 | 995,803 | 10,939,131 | 18,687,240 |
| Vault lights and ventilators | 14 | 120,750 | 138 | 81,184 | 140,719 | 338,111 |
| Vinegar and cider | 1,152 | 6,187,728 | 1,801 | 720,316 | 3,272,565 | 6,454,524 |
| Washing machines and clothes wringers | 118 | 2,404,569 | 1,509 | 548,707 | 2,174,762 | 3,735,243 |
| Watch and clock materials | 20 | 367,291 | 331 | 152,234 | 105,549 | 345,347 |
| Watch cases | 30 | 8,119,292 | 3,907 | 1,924,847 | 4,393,647 | 7,783,960 |
| Watch, clock, and jewelry repairing | 12,229 | 12,741,973 | 8,380 | 4,683,086 | 4,432,108 | 20,235,039 |
| Watches | 13 | 14,235,191 | 6,880 | 3,586,723 | 1,291,318 | 6,822,611 |
| Whalebone and rattan | 3 | 56,200 | 14 | 7,856 | 98,875 | 135,000 |
| Wheelbarrows | 15 | 513,467 | 321 | 127,398 | 180,036 | 454,441 |
| Whips | 60 | 1,893,703 | 1,287 | 478,176 | 1,278,324 | 2,734,471 |
| Windmills | 68 | 4,303,666 | 2,045 | 940,474 | 2,172,098 | 4,354,312 |
| Window shades | 207 | 5,507,842 | 2,012 | 871,532 | 6,046,062 | 8,868,259 |
| Wire | 29 | 4,242,173 | 1,603 | 859,645 | 7,014,319 | 9,421,238 |
| Wirework, including wire rope and cable | 597 | 16,374,629 | 9,255 | 3,934,525 | 10,858,229 | 19,942,882 |
| Wood, preserving | 21 | 1,229,746 | 478 | 205,105 | 1,825,355 | 2,395,748 |
| Wood, turned and carved | 1,171 | 10,278,418 | 11,569 | 4,375,345 | 5,835,492 | 14,338,503 |
| Woodenware, not elsewhere specified | 104 | 3,824,512 | 3,206 | 1,073,303 | 1,468,383 | 3,585,542 |
| Wool hats | 24 | 2,050,802 | 2,108 | 937,855 | 2,042,202 | 3,591,940 |
| Wool pulling | 34 | 944,715 | 475 | 247,950 | 53,975 | 531,287 |
| Wool scouring | 25 | 1,061,123 | 720 | 338,606 | 193,826 | 889,809 |
| Woolen goods | 1,035 | 124,386,262 | 68,893 | 24,757,006 | 71,011,956 | 118,430,158 |
| Worsted goods | 186 | 132,168,110 | 57,008 | 20,092,738 | 77,075,222 | 120,314,344 |
| Zinc, smelting and refining | 31 | 14,141,810 | 4,869 | 2,355,921 | 13,286,058 | 18,188,498 |
| All other industries | 4 | 447,959 | 132 | 58,661 | 299,339 | 503,449 |

## INDUSTRY GROUPS RANKED BY CAPITAL, NUMBER OF WAGE-EARNERS, WAGES, AND GROSS AND NET VALUE OF PRODUCTS: 1900.

[Twelfth Census, Vol. VII, page clxiv, and Vol. VIII, page 18.]

| Industry Group. | Number of Establishments. | Rank. | Capital. | Rank. | Average Number of Wage-earners. | Rank. |
|---|---|---|---|---|---|---|
| Total | 512,191 | ..... | $9,813,834,390 | ..... | 5,306,143 | ..... |
| Food and kindred products | 61,266 | 2 | 937,686,610 | 5 | 311,717 | 7 |
| Textiles | 30,048 | 4 | 1,366,604,058 | 2 | 1,029,910 | 1 |
| Iron and steel and their products | 13,896 | 11 | 1,528,979,076 | 1 | 733,968 | 2 |
| Lumber and its remanufact'res | 47,054 | 3 | 945,934,565 | 4 | 546,872 | 4 |
| Leather and its finished products | 16,989 | 7 | 343,600,513 | 13 | 238,202 | 10 |
| Paper and printing | 26,747 | 6 | 557,610,887 | 6 | 297,551 | 8 |
| Liquors and beverages | 7,861 | 13 | 534,101,049 | 7 | 63,072 | 14 |
| Chemicals and allied products | 5,443 | 14 | 498,282,219 | 8 | 101,489 | 13 |
| Clay, glass, and stone products | 14,809 | 10 | 350,902,367 | 12 | 244,987 | 9 |
| Metals and metal products, other than iron and steel | 16,305 | 8 | 410,646,057 | 9 | 190,757 | 11 |
| Tobacco | 15,252 | 9 | 124,089,871 | 14 | 142,277 | 12 |
| Vehicles for land transportati'n | 10,112 | 12 | 396,671,441 | 10 | 316,157 | 6 |
| Shipbuilding | 1,116 | 15 | 77,362,701 | 15 | 46,781 | 15 |
| Miscellaneous industries | 29,479 | 5 | 1,348,920,721 | 3 | 483,273 | 5 |
| Hand trades | 215,814 | 1 | 392,442,255 | 11 | 559,130 | 3 |

| Industry Group. | Wages. | Rank. | Value of Products. | | | |
|---|---|---|---|---|---|---|
| | | | Gross. | Rank. | Net. | Rank. |
| Total | $2,320,938,168 | ..... | $13,000,149,159 | ..... | $8,367,997,844 | ..... |
| Food and kindred products | 128,667,428 | 8 | 2,273,880,874 | 1 | 1,750,811,817 | 1 |
| Textiles | 341,734,399 | 2 | 1,637,484,484 | 3 | 1,081,961,248 | 2 |
| Iron and steel and their products | 381,875,499 | 1 | 1,793,490,908 | 2 | 983,821,918 | 3 |
| Lumber and its remanufactures | 212,124,780 | 4 | 1,030,695,350 | 5 | 547,227,860 | 6 |
| Leather and its finished products | 99,759,885 | 10 | 583,731,046 | 9 | 329,614,996 | 11 |
| Paper and printing | 140,092,453 | 7 | 606,317,768 | 8 | 419,798,101 | 7 |
| Liquors and beverages | 36,946,557 | 14 | 425,504,167 | 12 | 349,157,618 | 10 |
| Chemicals and allied products | 43,850,282 | 13 | 552,797,877 | 10 | 372,538,857 | 8 |
| Clay, glass, and stone products | 109,022,582 | 9 | 293,564,235 | 13 | 245,447,118 | 14 |
| Metals and metal products, other than iron and steel | 96,749,051 | 11 | 748,795,464 | 7 | 371,154,446 | 9 |
| Tobacco | 49,852,484 | 12 | 283,076,546 | 14 | 264,052,573 | 12 |
| Vehicles for land transportation | 164,559,022 | 6 | 508,524,510 | 11 | 250,622,377 | 13 |
| Shipbuilding | 24,839,163 | 15 | 74,578,158 | 15 | 42,492,518 | 15 |
| Miscellaneous industries | 202,746,162 | 5 | 1,004,092,294 | 6 | 638,191,538 | 5 |
| Hand trades | 288,118,421 | 3 | 1,183,615,478 | 4 | 721,104,859 | 4 |

## RANK OF INDUSTRIES WITH PRODUCTS

[Twelfth Census, Vol. VII, page

| Industry. | Number of Establishments. | Rank. | Capital. | Rank. |
|---|---|---|---|---|
| Iron and steel | 668 | 41 | $573,391,663 | 3 |
| Slaughtering and meat packing, not including retail butchering | 1,134 | 31 | 190,706,927 | 10 |
| Foundry and machine shop products | 9,324 | 15 | 665,058,245 | 1 |
| Lumber and timber products | 33,010 | 2 | 611,429,574 | 2 |
| Flouring and grist mill products | 25,258 | 4 | 218,714,104 | 9 |
| Clothing, men's | 28,014 | 3 | 173,034,543 | 13 |
| Printing and publishing | 22,312 | 5 | 292,517,072 | 8 |
| Cotton manufactures | 1,055 | 33 | 467,240,157 | 5 |
| Carpentering | 21,315 | 6 | 71,327,047 | 31 |
| Woolen manufactures | 1,414 | 28 | 310,179,749 | 7 |
| Boots and shoes, factory product | 1,600 | 26 | 101,795,233 | 21 |
| Sugar and molasses, refining | 832 | 37 | 184,245,519 | 11 |
| Liquors, malt | 1,509 | 27 | 415,284,468 | 6 |
| Cars and general shop construction and repairs by steam railroad companies | 1,295 | 30 | 119,473,042 | 16 |
| Leather, tanned, curried, and finished | 1,306 | 29 | 173,977,421 | 12 |
| Masonry, brick and stone | 8,333 | 16 | 48,070,239 | 39 |
| Bread and other bakery products | 14,917 | 9 | 81,049,553 | 28 |
| Lead, smelting and refining | 39 | 55 | 72,148,933 | 30 |
| Lumber, planing mill products, including sash, doors, and blinds | 4,204 | 22 | 119,271,631 | 17 |
| Copper, smelting and refining | 47 | 54 | 53,063,395 | 37 |
| Tobacco, cigars, and cigarettes | 14,539 | 10 | 67,706,493 | 32 |
| Clothing, women's, factory product | 2,701 | 23 | 48,431,544 | 38 |
| Furniture, including cabinetmaking, repairing, and upholstering | 7,972 | 17 | 117,982,091 | 19 |
| Plumbing, and gas and steam fitting | 11,876 | 13 | 47,111,264 | 40 |
| Cheese, butter, and condensed milk | 9,355 | 14 | 36,508,015 | 47 |
| Paper and wood pulp | 763 | 38 | 167,507,713 | 14 |
| Petroleum refining | 67 | 53 | 95,327,892 | 22 |
| Carriages and wagons | 7,632 | 18 | 118,187,838 | 18 |
| Silk and silk goods | 483 | 44 | 81,082,201 | 27 |
| Cars, railroad and street, and repairs, not including establishments operated by steam railroad companies | 193 | 52 | 106,721,188 | 20 |
| Tobacco, chewing, smoking, and snuff | 437 | 47 | 43,856,570 | 41 |
| Agricultural implements | 715 | 39 | 157,707,951 | 15 |
| Tinsmithing, coppersmithing, and sheet-iron working | 12,466 | 12 | 55,703,509 | 35 |
| Liquors, distilled | 967 | 34 | 32,551,604 | 51 |
| Hosiery and knit goods | 921 | 35 | 81,860,604 | 26 |
| Electrical apparatus and supplies | 580 | 42 | 83,130,943 | 24 |
| Painting and paper hanging | 16,939 | 7 | 27,217,086 | 55 |
| Blacksmithing and wheelwrighting | 51,771 | 1 | 54,976,341 | 36 |
| Marble and stone work | 6,070 | 19 | 67,509,533 | 33 |
| Confectionery | 4,297 | 21 | 35,155,361 | 48 |
| Gas, illuminating and heating | 877 | 36 | 567,000,506 | 4 |
| Shipbuilding | 1,116 | 32 | 77,362,701 | 29 |
| Millinery, custom work | 16,151 | 8 | 27,740,386 | 54 |
| Coffee and spice, roasting and grinding | 458 | 46 | 28,436,897 | 52 |
| Chemicals | 459 | 45 | 89,091,430 | 23 |
| Saddlery and harness | 12,934 | 11 | 43,354,136 | 42 |
| Patent medicines and compounds | 2,026 | 24 | 37,209,793 | 46 |
| Oil, cottonseed and cake | 369 | 49 | 34,451,461 | 49 |
| Fruits and vegetables, canning and preserving | 1,808 | 25 | 27,743,067 | 53 |
| Glass | 355 | 50 | 61,423,903 | 34 |
| Ironwork, architectural and ornamental | 672 | 40 | 33,062,409 | 50 |
| Soap and candles | 558 | 43 | 38,068,334 | 45 |
| Rubber and elastic goods | 262 | 51 | 39,304,853 | 44 |
| Brick and tile | 5,423 | 20 | 82,086,438 | 25 |
| Paints | 419 | 48 | 42,501,782 | 43 |

## VALUED AT OVER $50,000,000: 1900.

clxiii, and Vol. VIII, page 18.]

| Average Number of Wage-earners. | Rank. | Wages. | Rank. | Value of Products. | | | |
|---|---|---|---|---|---|---|---|
| | | | | Net. | Rank. | Gross. | Rank. |
| 222,490 | 4 | $120,820,276 | 2 | $432,687,119 | 3 | $803,968,273 | 1 |
| 69,441 | 17 | 33,923,253 | 15 | 684,119,221 | 1 | 790,252,586 | 2 |
| 350,327 | 1 | 182,232,009 | 1 | 377,812,876 | 4 | 644,990,999 | 3 |
| 283,179 | 3 | 104,563,603 | 3 | 307,838,590 | 5 | 566,621,755 | 4 |
| 37,073 | 34 | 17,703,418 | 35 | 540,052,649 | 2 | 560,719,063 | 5 |
| 191,043 | 5 | 79,434,932 | 7 | 220,140,823 | 8 | 415,256,391 | 6 |
| 162,992 | 7 | 84,249,954 | 6 | 264,859,062 | 7 | 347,055,050 | 7 |
| 302,861 | 2 | 86,689,752 | 5 | 296,633,150 | 6 | 339,200,320 | 8 |
| 123,985 | 10 | 71,049,737 | 8 | 176,611,706 | 12 | 316,101,758 | 9 |
| 159,108 | 8 | 57,933,817 | 10 | 218,637,292 | 9 | 296,990,484 | 10 |
| 142,922 | 9 | 59,175,883 | 9 | 93,701,767 | 19 | 261,028,580 | 11 |
| 14,262 | 45 | 6,945,811 | 46 | 49,216,847 | 40 | 240,969,905 | 12 |
| 39,532 | 33 | 25,826,211 | 23 | 202,582,268 | 10 | 237,269,713 | 13 |
| 173,595 | 6 | 96,006,570 | 4 | 111,622,240 | 16 | 218,113,658 | 14 |
| 52,109 | 26 | 22,591,091 | 27 | 186,389,057 | 11 | 204,038,127 | 15 |
| 93,568 | 13 | 53,152,258 | 11 | 125,356,555 | 14 | 203,593,634 | 16 |
| 60,271 | 21 | 27,893,170 | 21 | 89,262,303 | 23 | 175,657,348 | 17 |
| 8,319 | 52 | 5,088,684 | 49 | 97,425,341 | 18 | 175,466,304 | 18 |
| 73,627 | 16 | 32,685,210 | 16 | 74,205,166 | 28 | 168,343,003 | 19 |
| 11,324 | 49 | 8,529,021 | 42 | 76,502,702 | 26 | 165,131,670 | 20 |
| 103,462 | 11 | 40,925,596 | 13 | 152,300,012 | 13 | 160,223,152 | 21 |
| 83,739 | 14 | 32,586,101 | 17 | 75,315,179 | 27 | 159,339,539 | 22 |
| 100,018 | 12 | 42,638,810 | 12 | 91,151,488 | 22 | 153,168,309 | 23 |
| 53,916 | 24 | 31,873,866 | 18 | 68,035,688 | 30 | 131,852,567 | 24 |
| 12,865 | 46 | 6,170,670 | 48 | 124,008,573 | 15 | 131,199,277 | 25 |
| 49,646 | 27 | 20,746,426 | 32 | 77,954,480 | 25 | 127,326,162 | 26 |
| 12,199 | 47 | 6,717,087 | 47 | 107,512,092 | 17 | 123,929,384 | 27 |
| 62,540 | 19 | 29,814,911 | 19 | 67,172,479 | 31 | 121,537,276 | 28 |
| 65,416 | 18 | 20,982,194 | 31 | 86,483,994 | 24 | 107,256,258 | 29 |
| 44,063 | 31 | 23,342,763 | 26 | 39,326,856 | 47 | 107,186,359 | 30 |
| 29,161 | 39 | 7,109,821 | 45 | 92,915,542 | 20 | 103,754,362 | 31 |
| 46,582 | 29 | 22,450,880 | 28 | 60,535,599 | 36 | 101,207,428 | 32 |
| 45,575 | 30 | 22,155,039 | 29 | 51,638,038 | 38 | 100,310,720 | 33 |
| 3,722 | 55 | 1,733,218 | 55 | 91,451,293 | 21 | 96,798,443 | 34 |
| 83,387 | 15 | 24,358,627 | 25 | 54,544,999 | 37 | 95,482,566 | 35 |
| 40,890 | 32 | 20,190,344 | 33 | 44,583,830 | 41 | 91,348,889 | 36 |
| 59,191 | 22 | 34,822,819 | 14 | 62,541,861 | 35 | 88,396,852 | 37 |
| 36,193 | 36 | 17,974,264 | 34 | 63,764,914 | 34 | 85,971,630 | 38 |
| 54,370 | 23 | 28,663,241 | 20 | 69,097,079 | 29 | 85,101,591 | 39 |
| 33,583 | 37 | 10,867,687 | 38 | 44,179,706 | 42 | 81,290,543 | 40 |
| 22,459 | 41 | 12,436,296 | 36 | 64,276,431 | 33 | 75,716,693 | 41 |
| 46,781 | 28 | 24,839,163 | 24 | 42,492,518 | 46 | 74,578,158 | 42 |
| 33,298 | 38 | 9,570,536 | 40 | 34,529,813 | 51 | 70,363,752 | 43 |
| 6,387 | 54 | 2,486,759 | 54 | 64,741,832 | 32 | 69,527,108 | 44 |
| 19,054 | 44 | 9,401,467 | 41 | 36,918,124 | 48 | 62,676,730 | 45 |
| 24,123 | 40 | 10,725,647 | 39 | 30,677,173 | 52 | 62,630,902 | 46 |
| 11,809 | 48 | 4,407,988 | 50 | 43,819,968 | 44 | 59,611,335 | 47 |
| 11,007 | 50 | 3,143,459 | 53 | 43,196,446 | 45 | 58,726,632 | 48 |
| 36,401 | 35 | 8,050,793 | 44 | 36,668,635 | 49 | 56,668,313 | 49 |
| 52,818 | 25 | 27,084,710 | 22 | 43,905,999 | 43 | 56,539,712 | 50 |
| 20,646 | 42 | 11,111,226 | 37 | 23,398,179 | 54 | 53,508,179 | 51 |
| 9,487 | 51 | 3,754,767 | 52 | 24,228,062 | 53 | 53,231,017 | 52 |
| 20,405 | 43 | 8,082,738 | 43 | 35,278,808 | 50 | 52,627,030 | 53 |
| 61,979 | 20 | 21,883,333 | 30 | 50,312,022 | 39 | 51,270,476 | 54 |
| 8,151 | 53 | 3,929,787 | 51 | 18,545,525 | 55 | 50,874,995 | 55 |

## ESTABLISHMENTS AND PRODUCTS CLASSIFIED BY CHARACTER OF ORGANIZATION, BY GROUPS OF INDUSTRIES: 1900.*

[Twelfth Census, Vol. VII, pages lxvi and 503.]

| Industry Group. | Character of Organization. | | | |
|---|---|---|---|---|
| | Total. | | Individual. | |
| | Number of Establishments. | Value of Products. | Number of Establishments. | Value of Products. |
| Total. | 512,191 | $13,000,149,159 | 372,692 | $2,674,426,373 |
| Food and kindred products. | 61,266 | 2,273,880,874 | 42,569 | 444,230,465 |
| Textiles. | 30,048 | 1,637,484,484 | 18,701 | 262,342,066 |
| Iron and steel and their products. | 13,896 | 1,793,490,908 | 5,717 | 107,343,147 |
| Lumber and its remanufactures. | 47,054 | 1,030,695,350 | 28,463 | 265,781,468 |
| Leather and its finished products. | 16,989 | 533,731,046 | 12,906 | ..... |
| Paper and printing. | 26,747 | 603,317,768 | 16,392 | 127,110,593 |
| Liquors and beverages. | 7,861 | 425,504,167 | 5,063 | 69,353,112 |
| Chemicals and allied products. | 5,443 | 552,797,877 | 2,085 | ..... |
| Clay, glass, and stone products. | 14,809 | 293,564,235 | 8,761 | 69,147,764 |
| Metals and metal products, other than iron and steel. | 16,305 | 748,795,464 | 10,666 | ..... |
| Tobacco. | 15,252 | 283,076 546 | 12,803 | 79,919,991 |
| Vehicles for land transportation. | 10,112 | 503,524,510 | 5,750 | 43,223,011 |
| Shipbuilding. | 1,116 | 74,578,158 | 748 | 12,592,136 |
| Miscellaneous industries. | 29,479 | 1,004,032,294 | 18,545 | 173,848,128 |
| Hand trades. | 215,814 | 1,183,615,478 | 183,523 | 777,274,319 |

| Industry Group. | Character of Organization. | | | | | |
|---|---|---|---|---|---|---|
| | Firm and Limited Partnership. | | Incorporated Company. | | Cooperative and Miscellaneous. | |
| | Number of Establishments. | Value of Products. | Number of Establishments. | Value of Products. | Number of Establishments. | Value of Products. |
| Total. | 96,701 | $2,565,242,473 | 40,705 | $7,729,520,548 | 2,093 | $30,959,765 |
| Food and kindred products. | 11,905 | 394,387,619 | 4,994 | 1,410,298,055 | 1,798 | 24,964,735 |
| Textiles. | 8,084 | 547,349,114 | 3,245 | 827,705,447 | 18 | 87,857 |
| Iron and steel and their products. | 3,329 | 177,415,968 | 4,843 | 1,508,493,141 | 7 | 238,652 |
| Lumber and its remanufact'res. | 13,893 | 256,014,803 | 4,670 | 508,341,338 | 28 | 557,741 |
| Leather and its finished products. | 2,990 | 203,571,042 | 1,091 | 257,808,524 | 2 | ..... |
| Paper and printing. | 5,682 | 106,830,193 | 4,490 | 368,923,042 | 183 | 3,453,940 |
| Liquors and beverages. | 1,463 | ..... | 1,333 | 305,129,467 | 2 | ..... |
| Chemicals and allied products. | 1,152 | 60,181,725 | 2,205 | 450,008,084 | 1 | ..... |
| Clay, glass, and stone products. | 3,891 | 66,327,320 | 2,132 | 157,336,458 | 25 | 752,693 |
| Metal and metal products, other than iron and steel. | 4,167 | 88,143,271 | 1,470 | 578,172,577 | 2 | ..... |
| Tobacco. | 2,085 | 74,456,334 | 358 | 128,478,983 | 6 | 221,238 |
| Vehicles for land transportati'n | 2,079 | ..... | 2,282 | 430,731,303 | 1 | ..... |
| Shipbuilding. | 217 | 6,414,398 | 151 | 55,571,624 | ..... | ..... |
| Miscellaneous industries. | 6,174 | 188,153,370 | 4,750 | 641,875,764 | 10 | 215,032 |
| Hand trades. | 29,590 | 305,612,005 | 2,691 | 100,646,741 | 10 | 82,413 |

*In this table values have been omitted wherever they disclosed the products of individual establishments.

## ESTABLISHMENTS CLASSIFIED BY NUMBER OF EMPLOYEES, NOT INCLUDING PROPRIETORS AND FIRM MEMBERS: 1900.

[Twelfth Census, Vol. VII, pages lxxiii and 582.]

| Industry Group. | Total Number of Establishments. | Number of Establishments Reporting. | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | No. Employees. | Under 5. | 5 to 20. | 21 to 50. | 51 to 100. | 101 to 250. | 251 to 500. | 501 to 1000. | Over 1000. |
| Total | 512,191 | 110,509 | 232,716 | 112,120 | 32,403 | 11,658 | 8,475 | 2,804 | 1,063 | 443 |
| Food and kindred products | 61,266 | 14,611 | 34,759 | 8,129 | 1,888 | 912 | 696 | 161 | 81 | 29 |
| Textiles | 30,048 | 1,300 | 11,036 | 9,722 | 3,458 | 1,828 | 1,620 | 669 | 295 | 120 |
| Iron and steel and their products | 13,896 | 783 | 3,102 | 4,349 | 2,186 | 1,395 | 1,244 | 513 | 221 | 103 |
| Lumber and its remanufactures | 47,054 | 2,069 | 16,836 | 20,039 | 4,814 | 1,892 | 1,128 | 218 | 51 | 7 |
| Leather and its finished products | 16,989 | 5,028 | 8,163 | 1,644 | 857 | 560 | 472 | 196 | 50 | 19 |
| Paper and printing | 26,747 | 2,400 | 12,628 | 7,962 | 2,139 | 874 | 565 | 143 | 30 | 6 |
| Liquors and beverages | 7,861 | 671 | 4,185 | 2,070 | 569 | 228 | 103 | 27 | 6 | 2 |
| Chemicals and allied products | 5,443 | 643 | 1,607 | 1,689 | 806 | 390 | 224 | 64 | 10 | 10 |
| Clay, glass, and stone products | 14,809 | 1,022 | 3,876 | 6,121 | 2,186 | 857 | 562 | 134 | 42 | 9 |
| Metals and metal products, other than iron and steel | 16,305 | 2,950 | 8,029 | 3,542 | 951 | 386 | 291 | 85 | 51 | 20 |
| Tobacco | 15,252 | 3,637 | 7,273 | 3,004 | 672 | 309 | 233 | 85 | 28 | 11 |
| Vehicles for land transportation | 10,112 | 1,183 | 3,772 | 3,080 | 829 | 467 | 416 | 229 | 88 | 48 |
| Shipbuilding | 1,116 | 198 | 211 | 361 | 152 | 83 | 56 | 29 | 17 | 9 |
| Miscellaneous industries | 29,479 | 5,191 | 10,403 | 8,026 | 3,123 | 1,477 | 865 | 251 | 93 | 50 |
| Hand trades | 215,814 | 68,823 | [1] 106,836 | [2] 32,382 | [3] 7,773 | | | | | |

[1] Includes establishments with 1 to 5 employees.

[2] Includes establishments with 6 to 20 employees.

[3] Includes establishments with over 20 employees.

### AMERICAN IRRIGATION.

There are in the United States some 500,000,000 acres in what is known as the Arid Belt. These are not available for agriculture until they have been irrigated. "It is now estimated that at least 15,000,000 acres will be added to the available domain of the country during the first ten years" following the enactment of a new law, "while the authorities in charge of the work insist that under its operations it will be possible to bring into actual cultivation and use some years earlier than had been anticipated the 100,000 square miles included in the original estimate."

The new law referred to "repealed the previous enactment permitting single individuals to take up land to the amount of 160 acres under the Homestead timber culture and preemption systems, making 480 acres in all." It provided, among other things, that 160 acres should be the maximum. —London "Times," October 31, 1903.

### POPULATION OF EUROPE.

The population of Europe has been carefully estimated at recent dates by MM. Levasseur and Bodio with these results:

| YEAR. | POPULATION. |
|---|---|
| 1900 | 401,098,000 |
| 1886 | 346,700,000 |
| 1880 | 331,000,000 |
| 1878 | 325,700,000 |
| 1860 | 289,000,000 |

—Daily Mail Year Book.

## COST OF MATERIALS USED IN EACH OF THE FIFTEEN GROUPS OF INDUSTRIES: 1900.

[Twelfth Census, Vol. VII. page cxxxvii.]

| Industry Group. | Cost of Materials Used. | | | Per Cent of Cost of Materials to Gross Value of Products. | | Per Cent of Cost of Materials Purchased in Raw State of Net Value of Products. |
|---|---|---|---|---|---|---|
| | Purchased in Raw State. | Purchased in Partially Manufactured Form. | Fuel, Freight, etc. | Purchased in Partially Manufactured Form. | Purchased in Raw State. | |
| Total | $2,389,138,828 | $4,632,151,315 | $322,337,732 | 35 6 | 18.4 | 28.6 |
| Food and kindred products | 1,279,450,388 | 523,069,057 | 35,148,815 | 23.0 | 56.3 | 73.0 |
| Textiles | 314,089,230 | 555,523,236 | 26,372,330 | 33.9 | 19.2 | 29.0 |
| Iron and steel and their products | 74,781,646 | 809,668,990 | 102,747,734 | 45.1 | 4.2 | 7.6 |
| Lumber and its remanufactures | 64,502,232 | 483,467,490 | 13,440,897 | 46.9 | 6.3 | 11.8 |
| Leather and its finished products | 134,809,625 | 254,116,050 | 6,625,557 | 43.5 | 23.1 | 40.9 |
| Paper and printing | 11,396,844 | 186,519,667 | 16,241,912 | 30.8 | 1.9 | 2.7 |
| Liquor and beverages | 37,340,408 | 76,346,549 | 8,531,116 | 17.9 | 8.8 | 10.7 |
| Chemicals and allied products | 154,470,332 | 180,259,020 | 21,422,432 | 32.6 | 27.9 | 41.5 |
| Clay, glass, and stone products | 18,971,906 | 48,117,117 | 27,526,258 | 16.4 | 6.5 | 7.7 |
| Metals and metal products, other than iron and steel | 98,737,311 | 377,641,018 | 20,601,039 | 50.4 | 13.2 | 26.6 |
| Tobacco | 86,709,511 | 19,023,973 | 1,449,172 | 6.7 | 30.6 | 32.8 |
| Vehicles for land transportation | 1,342,802 | 257,902,133 | 8,966,610 | 50.7 | 0.3 | 0.5 |
| Shipbuilding | ..... | 32,085,640 | 1,401,132 | 43.0 | ..... | ..... |
| Miscellaneous industries | 103,685,431 | 365,900,756 | 20,487,518 | 36.4 | 10.3 | 16.2 |
| Hand trades | 8,851,162 | 462,510,619 | 11,375,210 | 39.1 | 0.7 | 1.2 |

## TOURISTS IN SWITZERLAND.

The following figures with regard to tourists in Switzerland have been compiled by Herr Freuler, of Zurich.

Money paid annually by visitors to hotel proprietors—between $15,000,000 and $20,000,000; paid to railway companies, etc., $3,375,000; gross profit is estimated at $12,375,000, from which $8,000 has to be taken for depreciation and improvements. The capital outlay is estimated at $120,000,000.

There are some 1,896 hotels and pensions, etc., with 104,800 beds; 945 are only open in the season, 951 are open all the year, 22,000 people find regular employment in these hotels, and 5,000 irregularly, with wages totaling 9 to 11 million francs and gratuities amounting to 3 1-2 to 4 million francs.—"Daily Mail" Year Book.

## JURA TUNNEL.

The Grand Council of the Canton of Berne, in the year 1903, agreed to grant a subvention for the construction of the projected Jura Tunnel for a line between Soleure and Munster, which will give access to the proposed tunnel through the Bernese Alps for communication with the Simplon Tunnel. An agreement has also been arrived at between the Federal Council and the Simplon Tunnel Company by which the latter will receive an increased amount for the construction of the Simplon Tunnel, but will not be liberated from its obligation to construct a second tunnel. The company agrees to transfer the tunnel to the Federal Government.

## VALUES OF DOMESTIC MERCHANDISE EXPORTED, GROUPED ACCORDING TO SOURCES OF PRODUCTION.

| Year ending June 30 | Exports of Domestic Merchandise other than Manufactures.[1] | | | | | | | | | | | | Exports of Domestic Manufactures. | | Total Exports of Domestic Merchandise. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Agriculture. | | Mining. | | Forest. | | Fisheries. | | Miscellaneous. | | Total. | | | | |
| | Values. | P. Ct. | Values. | P. Ct. | Values. | P. Ct. | Values. | P. Ct. | Values. | P. Ct. | Values. | P. Ct. | Values. | P. Ct. | Values. |
| | Dollars. | | Dollars. | | Dollars. | | Dollars. | | Dollars. | | Dollars. | | Dollars. | | Dollars. |
| 1860 | 256,560,972 | 81.13 | 999,465 | 0.31 | 10,299,959 | 3.26 | 4,156,480 | 1.31 | 3,879,655 | 1.23 | 275,896,531 | 87.24 | 40,345,892 | 12.76 | 316,242,423 |
| 1870 | 361,188,483 | 79.35 | 5,026,111 | 1.10 | 14,897,963 | 3.27 | 2,835,508 | .62 | 2,980,512 | .66 | 386,928,577 | 85 | 68,279,764 | 15 | 455,208,341 |
| 1880 | 685,961,091 | 83.25 | 5,863,232 | .71 | 17,321,268 | 2.11 | 5,255,402 | .64 | 6,689,345 | .81 | 721,090,338 | 87.52 | 102,856,015 | 12.48 | 823,946,353 |
| 1890 | 629,820,808 | 74.51 | 22,297,755 | 2.64 | 29,473,084 | 3.49 | 7,458,385 | .88 | 5,141,420 | .61 | 694,191,452 | 82.13 | 151,102,376 | 17.87 | 845,293,828 |
| 1900 | 835,858,123 | 60.98 | 37,843,742 | 2.76 | 52,218,112 | 3.81 | 6,326,620 | .46 | 4,665,218 | .34 | 936,911,815 | 68.35 | 433,851,756 | 31.65 | 1,370,763,571 |
| 1904 | 853,643,073 | 59.48 | 45,981,213 | 3.20 | 68,906,956 | 4.80 | 8,543,676 | .60 | 5,688,178 | .40 | 982,763,096 | 68.48 | 452,415,921 | 31.52 | 1,435,179,017 |

[1] The group "Other than Manufactures" embraces substantially all articles crude or only slightly enhanced in value by manufacture.

—Statistical Abstract of the United States.

DIVISION OF INDUSTRIES.—SEGMENTS ARE BASED ON PRODUCTION IN THE CENSUS YEAR 1890.

## SUMMARY OF EXPORTS OF DOMESTIC MERCHANDISE DURING THE YEAR ENDING JUNE 30, 1904.

(Bureau of Statistics).

| Articles. | Quantities. | Values. |
|---|---|---|
| AGRICULTURAL IMPLEMENTS: | | Dollars. |
| Mowers and reapers, and parts of | | 11,568,062 |
| Plows and cultivators, and parts of | | 3,537,810 |
| All other, and parts of | | 7,643,763 |
| Total | | 22,749,635 |
| Aluminum, and manufactures of | | 183,197 |
| ANIMALS: | | |
| Cattle No. | 593,409 | 42,256,291 |
| Hogs No. | 6,345 | 53,780 |
| Horses No. | 42,001 | 3,189,100 |
| Mules No. | 3,658 | 412,971 |
| Sheep No. | 301,313 | 1,954,604 |
| All other, including fowls | | 111,129 |
| Total | | 47,977,875 |
| Art works: Paintings and statuary | | 409,694 |
| Asbestos, and manufactures of | | 183,962 |
| Asphaltum, and manufactures of | | 160,186 |
| Bark, and extract of, for tanning | | 291,783 |
| Beeswax lbs | 55,631 | 16,545 |
| Billiard balls | | 656 |
| BLACKING: | | |
| Stove polish | | 70,394 |
| All other | | 527,003 |
| Bones, hoofs, horns, and horn tips, strips, and waste | | 208,523 |
| Books, maps, engravings, etchings, and other printed matter | | 4,347,304 |
| Brass, and manufactures of | | 2,557,484 |
| BREADSTUFFS: | | |
| Barley bush | 10,881,627 | 6,292,914 |
| Bread and biscuit lbs | 12,071,261 | 635,133 |
| Buckwheat bush | 31,006 | 19,827 |
| Corn bush | 55,858,965 | 30,071,334 |
| Corn meal bbls | 590,774 | 1,691,669 |
| Oats bush | 1,153,714 | 475,362 |
| Oatmeal lbs | 14,526,477 | 463,062 |
| Rye bush | 765,108 | 440,980 |
| Rye flour bbls | 3,160 | 11,302 |
| Wheat bush | 44,230,169 | 35,850,318 |
| Wheat flour bbls | 16,999,432 | 68,894,836 |
| Preparations of, for table food | | 2,172,571 |
| All other, for animal feed— | | |
| Bran, middlings, and mill feed tons | 19,193 | 366,213 |
| Dried grains and malt sprouts tons | 56,038 | 1,062,336 |
| All other | | 602,521 |
| Total | | 149,050,378 |
| BRICKS: | | |
| Building M | 15,814 | 112,200 |
| Fire | | 387,227 |
| Total | | 499,427 |
| Broom corn | | 226,179 |
| Brooms and brushes | | 275,522 |
| Candles lbs | 6,048,640 | 510,183 |

SUMMARY OF EXPORTS OF DOMESTIC MERCHANDISE—*Continued.*

| Articles. | Quantities. | Values. |
|---|---|---|
| CARRIAGES, CARS, OTHER VEHICLES, AND PARTS OF: | | Dollars. |
| Automobiles, and parts of | | 1,895,605 |
| Cars, passenger and freight, and parts of— | | |
| For steam railways | | 2,607,592 |
| For other railways | | 763,144 |
| Cycles, and parts of | | 1,965,026 |
| Wheelbarrows, push carts, and hand trucks | | 350,450 |
| All other carriages and parts of | | 3,354,801 |
| Total | | 10,936,618 |
| Celluloid, and manufactures of | | 246,601 |
| Cement | bbls. 362,503 | 530,216 |
| CHEMICALS, DRUGS, DYES, AND MEDICINES: | | |
| Acids | | 245,813 |
| Ashes, pot and pearl | lbs. 1,027,181 | 56,800 |
| Baking powder | lbs. 1,032,931 | 326,231 |
| Copper, sulphate of | lbs. 26,077,087 | 1,133,686 |
| Dyes and dyestuffs | | 517,878 |
| Ginseng | lbs. 131,882 | 851,820 |
| Lime, acetate of | lbs. 64,256,945 | 1,103,389 |
| Medicines, patent or proprietary | | 3,897,793 |
| Roots, herbs, and barks, not elsewhere specified | | 266,809 |
| Washing powders or mixtures, etc | lbs. 6,409,512 | 349,869 |
| All other | | 5,730,235 |
| Total | | 14,480,323 |
| Cider | galls. 714,476 | 103,314 |
| Clay | | 158,926 |
| CLOCKS AND WATCHES: | | |
| Clocks, and parts of | | 1,186,279 |
| Watches, and parts of | | 1,094,916 |
| Total | | 2,281,195 |
| COAL AND COKE: | | |
| Coal— | | |
| Anthracite | tons. 2,048,154 | 10,097,808 |
| Bituminous | tons. 6,434,713 | 17,722,515 |
| Total coal | tons. 8,482,867 | 27,820,323 |
| Coke | tons. 479,431 | 2,223,233 |
| Cocoa, ground or prepared, and chocolate | | 250,084 |
| COFFEE: | | |
| Raw or green | lbs. 32,208,497 | 3,656,943 |
| Roasted or prepared | lbs. 405,893 | 64,516 |
| COPPER AND MANUFACTURES OF: | | |
| Ore | tons. 15,311 | 976,925 |
| Ingots, bars, plates, and old | lbs. 422,595,277 | 54,870,072 |
| All other manufactures of | | 2,272,009 |
| Total, not including ore | | 57,142,081 |
| Cork, manufactures of | | 39,581 |
| COTTON, AND MANUFACTURES OF: | | |
| Unmanufactured— | | |
| Sea Island | lbs. 13,254,404 | 3,154,376 |
| Upland and other | lbs. 3,049,938,356 | 367,656,870 |
| Total unmanufactured | bales. 6,009,194 / lbs. 3,063,192,760 | 370,811,246 |
| Linter's | lbs. 26,663,146 | 1,238,018 |

SUMMARY OF EXPORTS OF DOMESTIC MERCHANDISE—*Continued.*

| Articles. | Quantities. | Values. |
|---|---|---|
| COTTON, AND MANUFACTURES OF—(*Continued*). | | Dollars. |
| Manufactures of— | | |
| Cloths— | | |
| Colored.....yds... | 91,319,979 | 5,439,277 |
| Uncolored.....yds... | 156,060,758 | 9,256,922 |
| Total cloths.....yds... | 247,380,737 | 14,696,199 |
| Wearing apparel..... | ..... | 2,700,420 |
| Waste, cotton, cop and mill.....lbs .. | 26,258,471 | 1,585,765 |
| Yarn..... | ..... | 172,286 |
| All other..... | ..... | 3,249,043 |
| Total manufactures..... | ..... | 22,403,713 |
| Dental goods..... | ..... | 520,678 |
| EARTHEN, STONE, AND CHINA WARE: | | |
| Earthen and stone ware..... | ..... | 614,130 |
| China ware..... | ..... | 78,704 |
| Total..... | ..... | 692,834 |
| Eggs.....doz... | 1,776,632 | 396,408 |
| EMERY, AND MANUFACTURES OF: | | |
| Wheels..... | ..... | 288,387 |
| All other..... | ..... | 13,602 |
| Feathers..... | ..... | 157,035 |
| Phosphates, crude.....tons... | 849,130 | 6,517,396 |
| All other.....tons .. | 22,101 | 595,116 |
| FIBRES, VEGETABLE, AND TEXTILE GRASSES, MANUFACTURES OF: | | |
| Bags..... | ..... | 301,413 |
| Cordage.....lbs... | 9,490,289 | 926,287 |
| Twine..... | ..... | 4,396,364 |
| All other..... | ..... | 790,581 |
| Total..... | ..... | 6,414,636 |
| FISH: | | |
| Fresh, other than salmon.....lbs... | 1,570,084 | 73,727 |
| Dried, smoked, or cured— | | |
| Cod, haddock, hake, and pollock.....lbs... | 3,511,676 | 167,103 |
| Herring.....lbs... | 1,476,110 | 44,336 |
| All other.....lbs... | 180,075 | 10,295 |
| Pickled— | | |
| Mackerel.....bbls... | 576 | 7,848 |
| All other.....bbls... | 8,689 | 41,784 |
| Salmon— | | |
| Canned.....lbs... | 55,924,278 | 5,224,598 |
| All other, fresh or cured..... | ..... | 1,163,489 |
| Canned fish, other than salmon and shellfish..... | ..... | 115,283 |
| Caviare..... | ..... | 16,462 |
| Shellfish— | | |
| Oysters..... | ..... | 610,762 |
| All other..... | ..... | 311,315 |
| All other fish and fish products..... | ..... | 70,039 |
| Total..... | ..... | 7,857,041 |
| FRUITS AND NUTS: | | |
| Apples, dried.....lbs .. | 48,301,665 | 2,791,421 |
| Apples, green or ripe.....bbls... | 2,018,262 | 5,446,473 |
| Apricots, dried.....lbs... | 7,205,686 | 608,511 |
| Oranges..... | ..... | 739,593 |
| Prunes.....lbs... | 73,146,214 | 3,410,497 |
| Raisins.....lbs... | 4,020,418 | 281,402 |
| All other green, ripe, or dried..... | ..... | 4,317,910 |

SUMMARY OF EXPORTS OF DOMESTIC MERCHANDISE—*Continued.*

| Articles. | Quantities. | Values. |
|---|---|---|
| FRUITS AND NUTS—(*Continued*). | | |
| Preserved— | | Dollars. |
| Canned | | 2,637,002 |
| All other | | 115,490 |
| Nuts | | 330,366 |
| Total | | 20,678,665 |
| Furniture of metal | | 157,456 |
| Furs and fur skins | | 5,422,945 |
| Ginger ale.....doz. qts... | 1,388 | 1,633 |
| GLASS AND GLASSWARE: | | |
| Window glass | | 71,498 |
| All other | | 1,906,983 |
| Total | | 1,978,481 |
| Glucose or grape sugar.....lbs... | 152,768,716 | 2,949,545 |
| Glue.....lbs... | 2,656,057 | 258,511 |
| Grease, grease scraps, and all soap stock | | 3,311,777 |
| GUNPOWDER AND OTHER EXPLOSIVES: | | |
| Gunpowder.....lbs... | 965,740 | 136,383 |
| All other explosives | | 2,305,213 |
| Total | | 2,441,596 |
| Hair, and manufactures of | | 724,514 |
| Hay.....tons... | 60,730 | 1,052,705 |
| Hides and skins, other than furs.....lbs... | 32,727,643 | 3,246,887 |
| Honey | | 69,317 |
| Hops.....lbs... | 10,985,988 | 2,116,180 |
| Household and personal effects | | 2,615,076 |
| Ice.....tons... | 17,746 | 27,983 |
| INDIA RUBBER, MANUFACTURES OF: | | |
| India rubber, reclaimed | | 178,335 |
| India rubber, scrap and old | | 534,500 |
| Belting, hose, and packing | | 880,010 |
| Boots and shoes.....pairs... | 2,310,808 | 1,086,364 |
| All other | | 2,469,750 |
| Total | | 5,148,959 |
| INK: | | |
| Printers' | | 238,314 |
| All other | | 136,021 |
| INSTRUMENTS AND APPARATUS FOR SCIENTIFIC PURPOSES: | | |
| Electrical appliances, including telegraph and telephone instruments | | 4,861,204 |
| All other | | 3,436,519 |
| IRON AND STEEL, AND MANUFACTURES OF: | | |
| Iron ore.....tons... | 83,004 | 254,349 |
| Pig iron.....tons... | 34,635 | 605,976 |
| Scrap and old, fit only for remanufacture.....tons... | 16,845 | 248,093 |
| Bar Iron.....lbs... | 50,778,091 | 936,145 |
| Bars or rods of steel— | | |
| Wire rods.....lbs... | 35,348,920 | 503,298 |
| All other.....lbs... | 48,039,837 | 1,014,934 |
| Billets, ingots, and blooms.....tons... | 176,961 | 3,582,126 |
| Hoop, band, and scroll.....lbs... | 6,360,034 | 145,715 |
| Rails for railways— | | |
| Iron.....tons... | 1,513 | 30,005 |
| Steel.....tons... | 160,894 | 4,253,376 |

SUMMARY OF EXPORTS OF DOMESTIC MERCHANDISE—*Continued.*

| Articles. | Quantities. | Values. |
|---|---|---|
| IRON AND STEEL, AND MANUFACTURES OF—(*Continued*). | | |
| | | Dollars. |
| Sheets and plates— | | |
| Iron.....lbs... | 13,286,217 | 313,474 |
| Steel.....lbs... | 42,897,543 | 839,922 |
| Tin plates, terne plates and taggers tin.....lbs... | 8,107,666 | 306,930 |
| Structural iron and steel.....tons... | 35,884 | 1,943,281 |
| Wire.....lbs... | 255,036,565 | 5,821,921 |
| Builders' hardware, saws, and tools— | | |
| Locks, hinges, and other builders' hardware | | 6,156,170 |
| Saws | | 533,459 |
| Tools, not elsewhere specified | | 5,006,562 |
| Car wheels.....No... | 23,035 | 159,706 |
| Castings, not elsewhere specified | | 1,544,850 |
| Cutlery— | | |
| Table | | 107,826 |
| All other | | 339,812 |
| Firearms | | 1,520,396 |
| Machinery, machines, and parts of— | | |
| Cash registers.....No... | 19,935 | 1,836,233 |
| Electrical | | 5,645,809 |
| Laundry machinery | | 553,912 |
| Metal working | | 3,716,709 |
| Printing presses, and parts of | | 1,393,746 |
| Pumps and pumping machinery | | 2,703,397 |
| Sewing machines, and parts of | | 5,623,423 |
| Shoe machinery | | 1,071,090 |
| Steam engines, and parts of— | | |
| Fire.....No... | 7 | 12,527 |
| Locomotive.....No... | 504 | 5,261,422 |
| Stationary.....No... | 1,882 | 1,059,401 |
| Boilers, and parts of engines | | 2,169,753 |
| Typewriting machines, and parts of | | 4,537,125 |
| Wood-working machinery | | 738,609 |
| All other | | 19,894,135 |
| Total machinery | | 56,230,291 |
| Nails and spikes— | | |
| Cut.....lbs... | 21,448,899 | 445,033 |
| Wire.....lbs... | 72,646,550 | 1,517,876 |
| All other, including tacks.....lbs... | 5,735,493 | 309,054 |
| Pipes and fittings | | 6,310,551 |
| Safes.....No... | 4,213 | 222,812 |
| Scales and balances | | 652,303 |
| Stoves, ranges, and parts of | | 881,603 |
| All other manufactures of iron and steel | | 9,435,056 |
| Total, iron and steel, not including ore | | 111,948,586 |
| Jewelers' ashes and sweepings | | 86,349 |
| JEWELRY, AND MANUFACTURES OF GOLD AND SILVER: | | |
| Jewelry | | 964,659 |
| All other manufactures of gold and silver | | 400,995 |
| Lamps, chandeliers, and all other devices for illuminating purposes | | 1,502,888 |
| LEAD, AND MANUFACTURES OF: | | |
| Pigs, bars, and old.....lbs... | 83,547 | 4,384 |
| Type.....lbs... | 368,892 | 128,471 |
| All other manufactures of | | 405,165 |
| LEATHER, AND MANUFACTURES OF: | | |
| Sole leather.....lbs... | 36,830,717 | 6,978,497 |
| Upper leather— | | |
| Kid, glazed | | 1,512,179 |
| Patent or enameled | | 170,940 |
| Splits, buff, grain, and all other upper | | 15,049,602 |
| All other leather | | 1,140,364 |
| Manufactures of— | | |
| Boots and shoes.....pairs... | 4,642,431 | 7,238,940 |
| Harness and saddles | | 550,346 |
| All other | | 1,329,747 |
| Total leather, and manufactures of | | 33,980,615 |

SUMMARY OF EXPORTS OF DOMESTIC MERCHANDISE—*Continued.*

| Articles. | Quantities. | Values. |
|---|---|---|
| | | Dollars. |
| Lime.....bbls... | 65,755 | 52,984 |
| Malt.....bush... | 438,580 | 315,676 |
| MARBLE AND STONE, AND MANUFACTURES: | | |
| Unmanufactured..... | | 217,789 |
| Manufactures of— | | |
| Roofing slate..... | | 726,715 |
| All other..... | | 645,286 |
| Total marble and stone, and manufactures of..... | | 1,589,790 |
| Matches..... | | 68,003 |
| MUSICAL INSTRUMENTS: | | |
| Organs.....No... | 14,624 | 1,095,415 |
| Pianofortes.....No... | 1,901 | 404,454 |
| Pianolas and other piano players..... | 4,282 | 889,951 |
| All other, and parts of..... | | 841,162 |
| Total..... | | 3,230,982 |
| NAVAL STORES: | | |
| Rosin.....bbls... | 2,585,108 | 6,621,870 |
| Tar.....bbls... | 15,644 | 44,944 |
| Turpentine and pitch.....bbls... | 13,177 | 32,253 |
| Turpentine, spirits of.....galls... | 17,202,808 | 9,446,155 |
| Total..... | | 16,145,222 |
| Nickel, nickel oxide and matte.....lbs... | 3,461,371 | 940,558 |
| Nursery stock..... | | 287,880 |
| Oakum..... | | 34,020 |
| Corn.....lbs... | 14,014,885 | 169,921 |
| Cotton-seed.....lbs... | 820,349,073 | 9,134,088 |
| Flaxseed or linseed.....lbs... | 668,868,722 | 7,765,169 |
| OILCLOTHS: | | |
| For floors..... | | 45,571 |
| All other..... | | 185,726 |
| OILS: | | |
| Animal— | | |
| Fish.....galls... | 867,434 | 213,257 |
| Lard.....galls... | 376,826 | 244,499 |
| Whale.....galls... | 13,649 | 10,197 |
| All other.....galls... | 452,481 | 273,481 |
| Total animal..... | | 741,434 |
| Mineral, crude, including all natural oils, without regard to gravity.....galls... | 114,576,920 | 6,572,923 |
| Mineral, refined or manufactured— | | |
| Naphthas, including all lighter products of distillation.galls. | 16,910,121 | 1,802,207 |
| Illuminating.....galls... | 741,567,036 | 57,902,503 |
| Lubricating, and heavy paraffin oil.....galls... | 88,810,130 | 12,048,842 |
| Residuum, including tar, and all other, from which the light bodies have been distilled.....bbls... | 537,155 | 733,994 |
| Total mineral..... | | 79,060,469 |
| Vegetable— | | |
| Corn.....galls... | 3,222,875 | 998,613 |
| Cotton-seed.....galls... | 29,013,743 | 10,717,280 |
| Linseed.....galls... | 336,419 | 147,721 |
| Volatile or essential— | | |
| Peppermint.....lbs... | 42,939 | 124,728 |
| All other..... | | 440,588 |
| All other vegetable..... | | 189,451 |
| Total vegetable..... | | 12,618,381 |

SUMMARY OF EXPORTS OF DOMESTIC MERCHANDISE—*Continued.*

| Articles. | Quantities. | Values. |
|---|---|---|
| | | Dollars. |
| PAINTS, PIGMENTS, AND COLORS: | | |
| Carbon black, gas black, and lamp black | | 329,013 |
| Zinc, oxide of | lbs. 16,768,227 | 672,436 |
| All other | | 1,755,132 |
| Total | | 2,756,581 |
| PAPER, AND MANUFACTURES OF: | | |
| Paper hangings | | 243,417 |
| Playing cards | | 210,518 |
| Printing paper | lbs. 92,009,511 | 2,572,447 |
| Writing paper and envelopes | | 887,181 |
| All other | | 3,630,165 |
| Total | | 7,543,728 |
| Paraffin and paraffin wax | lbs. 188,651,119 | 8,859,964 |
| Perfumery and cosmetics | | 480,567 |
| Photographic materials | | 127,501 |
| Plated ware | | 693,618 |
| Platinum, and manufactures of | | 12,097 |
| PROVISIONS, COMPRISING MEAT AND DAIRY PRODUCTS: | | |
| Meat products— | | |
| Beef products— | | |
| Beef, canned | lbs. 57,468,338 | 5,882,888 |
| Beef, fresh | lbs. 299,579,671 | 26,841,586 |
| Beef, salted or pickled | lbs. 57,584,710 | 3,260,475 |
| Beef, other cured | lbs. 269,112 | 20,542 |
| Tallow | lbs. 79,924,174 | 3,801,302 |
| Hog products— | | |
| Bacon | lbs. 249,665,941 | 24,446,752 |
| Hams | lbs. 194,948,864 | 22,293,867 |
| Pork, canned | lbs. 9,479,312 | 963,321 |
| Pork, fresh | lbs. 18,633,820 | 1,669,818 |
| Pork, salted or pickled | lbs. 112,224,861 | 9,527,388 |
| Lard | lbs. 561,302,643 | 46,347,520 |
| Lard compounds, and substitutes for (cottolene, lardine, etc.) | lbs. 53,603,545 | 3,581,813 |
| Mutton | lbs. 465,255 | 40,618 |
| Oleo and oleomargarine— | | |
| Oleo, the oil | lbs. 165,183,839 | 12,873,558 |
| Oleomargarine, imitation butter | lbs. 6,137,251 | 605,874 |
| Poultry and game | | 1,009,304 |
| Sausage and sausage meat | lbs. 5,562,349 | 602,528 |
| Sausage casings | | 2,353,167 |
| All other meat products— | | |
| Canned | | 2,254,235 |
| All other | | 2,062,813 |
| Dairy products— | | |
| Butter | lbs. 10,717,824 | 1,768,184 |
| Cheese | lbs. 23,335,172 | 2,452,239 |
| Milk | | 1,367,794 |
| Total provisions, etc | | 176,027,586 |
| Quicksilver | lbs. 1,546,521 | 834,764 |
| Quills, crude and prepared | | 23,164 |
| Rags and paper stock | | 110,948 |
| Rice | lbs. 2,380,418 | 88,465 |
| Rice bran, meal, and polish | lbs. 26,741,345 | 200,263 |
| Salt | lbs. 25,508,577 | 99,066 |
| Sand | | 70,895 |
| SEEDS: | | |
| Clover | lbs. 6,440,618 | 600,626 |
| Cotton | lbs. 12,859,756 | 141,174 |
| Flaxseed or linseed | bush. 758,379 | 820,668 |

SUMMARY OF EXPORTS OF DOMESTIC MERCHANDISE—*Continued.*

| Articles. | Quantities. | Values. |
|---|---|---|
| SEEDS.—*Continued.* | | Dollars. |
| Timothy.....lbs... | 12,672,676 | 480,946 |
| Other grass seeds..... | ..... | 299,649 |
| All other..... | ..... | 240,262 |
| Total..... | ..... | 2,582,325 |
| Shells..... | ..... | 135,696 |
| SILK: | | |
| Manufactures of..... | ..... | 466,519 |
| Waste.....lbs... | 227,139 | 30,814 |
| SOAP: | | |
| Toilet or fancy..... | ..... | 721,776 |
| All other.....lbs... | 45,134,340 | 1,778,157 |
| Total..... | ..... | 2,499,933 |
| Spermaceti and spermaceti wax.....lbs... | 181,772 | 39,964 |
| Spices..... | ..... | 28,521 |
| SPIRITS, WINES, AND MALT LIQUORS: | | |
| Malt liquors— | | |
| In bottles.....doz... | 540,301 | 769,432 |
| In other coverings.....galls... | 382,346 | 84,687 |
| Total malt liquors..... | ..... | 854,119 |
| Spirits, distilled— | | |
| Alcohol— | | |
| Wood.....proof galls... | 1,194,466 | 585,359 |
| All other, including pure, neutral, or cologne spirits proof galls... | 587,549 | 112,291 |
| Brandy.....proof galls... | 70,193 | 44,119 |
| Rum.....proof galls... | 757,227 | 994,959 |
| Whisky— | | |
| Bourbon.....proof galls... | 231,540 | 254,693 |
| Rye.....proof galls... | 127,535 | 217,551 |
| All other.....proof galls... | 47,402 | 67,854 |
| Total spirits, distilled..... | ..... | 2,276,826 |
| Wine— | | |
| In bottles.....doz... | 6,066 | 33,136 |
| In other coverings.....galls... | 896,643 | 403,557 |
| Total wines..... | ..... | 436,693 |
| Total spirits, wines, and malt liquors..... | ..... | 3,567,638 |
| Sponges.....lbs... | 64,214 | 36,646 |
| Starch.....lbs... | 57,185,739 | 1,340,282 |
| Stationery, except of paper— | | |
| Mucilage..... | ..... | 12,527 |
| Paste..... | ..... | 6,313 |
| Pencils..... | ..... | 261,671 |
| Pens and penholders..... | ..... | 62,595 |
| Stereotype and electrotype plates..... | ..... | 26,957 |
| Straw and palm leaf, manufactures of..... | ..... | 471,392 |
| SUGAR, MOLASSES, AND CONFECTIONERY: | | |
| Molasses.....galls... | 3,819,139 | 592,288 |
| Sirup.....galls... | 12,901,957 | 1,846,563 |
| Sugar— | | |
| Brown.....lbs... | 113,977 | 3,427 |
| Refined.....lbs... | 15,304,560 | 528,616 |
| Candy and confectionery..... | ..... | 551,911 |
| Total..... | ..... | 3,522,805 |

SUMMARY OF EXPORTS OF DOMESTIC MERCHANDISE—*Continued.*

| Articles. | Quantities. | Values. |
|---|---|---|
| | | Dollars. |
| Teeth, artificial | | 7,913 |
| Tin, manufactures of | | 731,553 |
| TOBACCO, AND MANUFACTURES OF: | | |
| Unmanufactured— | | |
| Leaf.....lbs. | 305,382,128 | 29,464,732 |
| Stems and trimmings.....lbs. | 6,589,703 | 176,080 |
| Manufactures of— | | |
| Cigars.....M. | 1,953 | 36,545 |
| Cigarettes.....M. | 1,528,406 | 2,320,112 |
| Plug.....lbs. | 6,900,598 | 1,700,028 |
| All other | | 986,034 |
| Total | | 34,683,531 |
| Toys | | 308,067 |
| Trunks, valises, and traveling bags | | 174,372 |
| Varnish.....galls. | 713,147 | 726,585 |
| Vegetables: | | |
| Beans and pease.....bush. | 248,805 | 546,479 |
| Onions.....bush. | 144,764 | 116,104 |
| Potatoes.....bush. | 484,042 | 436,135 |
| Vegetables, canned | | 719,580 |
| All other, including pickles and sauces | | 785,076 |
| Total | | 2,603,374 |
| VESSELS SOLD ABROAD: | | |
| Steamers.....No. | 86 | 210,048 |
| Sailing vessels.....No. | | |
| Total | | 210,048 |
| Vinegar.....galls. | 132,450 | 19,192 |
| Whalebone.....lbs. | 49,897 | 250,875 |
| WOOD, AND MANUFACTURES OF: | | |
| Timber and unmanufactured wood— | | |
| Sawed.....M feet | 558,690 | 8,472,355 |
| Hewn.....cubic feet | 3,788,740 | 881,557 |
| Logs, and other | | 4,473,297 |
| Lumber— | | |
| Boards, deals, and planks.....M feet | 1,426,784 | 28,603,355 |
| Joists and scantling.....M feet | 60,119 | 875,062 |
| Shingles.....M. | 28,484 | 82,377 |
| Shooks— | | |
| Box | | 869,802 |
| All other.....No. | 533,182 | 795,595 |
| Staves.....No. | 47,420,095 | 4,032,344 |
| Heading | | 170,874 |
| All other | | 3,190,687 |
| Manufactures of— | | |
| Doors, sash, and blinds | | 1,433,037 |
| Furniture, not elsewhere specified | | 4,555,411 |
| Hogsheads and barrels, empty | | 215,532 |
| Trimmings, moldings, and other house finishings | | 561,504 |
| Wooden ware | | 981,888 |
| Wood pulp.....lbs. | 30,230,820 | 593,474 |
| All other | | 4,640,266 |
| Total wood, and manufactures of | | 65,428,417 |
| WOOL, AND MANUFACTURES OF: | | |
| Wool, raw.....lbs. | 319,750 | 37,171 |
| Carpets.....yds. | 60,723 | 50,921 |
| Dress goods.....yds. | 15,814 | 7,829 |

SUMMARY OF EXPORTS OF DOMESTIC MERCHANDISE—*Continued.*

| Articles. | Quantities. | Values. |
|---|---|---|
| WOOL, AND MANUFACTURES OF.—*Continued.* | | Dollars. |
| Flannels and blankets | | 105,044 |
| Wearing apparel | | 1,457,748 |
| All other manufactures of | | 366,396 |
| Total manufactures | | 1,987,938 |
| Yeast | | 18,772 |
| ZINC, AND MANUFACTURES OF: | | |
| Dross | | 645,311 |
| Ore | 28,913 tons | 806,190 |
| Manufactures of— | | |
| Pigs, bars, plates, and sheets | 3,432,728 lbs. | 185,965 |
| All other manufactures of | | 72,745 |
| Total zinc, etc., not including dross or ore | | 258,710 |
| All other articles | | 1,268,651 |
| Total value of exports of domestic merchandise | | 1,435,179,017 |

## MERCHANDISE IMPORTED AND EXPORTED, AND THE ANNUAL EXCESS OF IMPORTS OR OF EXPORTS, 1860 TO 1904— SPECIE VALUES.

| Year ending June 30 | Exports. | | | Imports. | Total Exports and Imports. | Excess of Exports over Imports. | Excess of Imports over Exports. |
|---|---|---|---|---|---|---|---|
| | Domestic. | Foreign. | Total. | | | | |
| | Dollars. | Dollars. | Dollars. | Dollars. | Dollars. | Dollars. | Dollars. |
| 1860 | 316,242,423 | 17,333,634 | 333,576,057 | 353,616,119 | 687,192,176 | ..... | 20,040,662 |
| 1861 | 204,899,616 | 14,654,217 | 219,553,833 | 289,310,542 | 508,864,375 | ..... | 69,756,709 |
| 1862 | 179,644,024 | 11,026,477 | 190,670,501 | 189,356,677 | 380,027,178 | 1,313,824 | ..... |
| 1863 | 186,003,912 | 17,960,535 | 203,964,447 | 243,335,815 | 447,300,262 | ..... | 39,371,368 |
| 1864 | 143,504,027 | 15,333,961 | 158,837,988 | 316,447,283 | 475,285,271 | ..... | 157,609,295 |
| 1865 | 136,940,248 | 29,089,055 | 166,029,303 | 238,745,580 | 404,774,883 | ..... | 72,716,277 |
| 1866 | 337,518,102 | 11,341,420 | 348,859,522 | 434,812,066 | 783,671,588 | ..... | 85,952,544 |
| 1867 | 279,786,809 | 14,719,332 | 294,506,141 | 395,761,096 | 690,267,237 | ..... | 101,254,955 |
| 1868 | 269,389,900 | 12,562,999 | 281,952,899 | 357,436,440 | 639,389,339 | ..... | 75,483,541 |
| 1869 | 275,166,697 | 10,951,000 | 286,117,697 | 417,506,379 | 703,624,076 | ..... | 131,388,682 |
| 1870 | 376,616,473 | 16,155,295 | 392,771,768 | 435,958,408 | 828,730,176 | ..... | 43,186,640 |
| 1871 | 428,398,908 | 14,421,270 | 442,820,178 | 520,223,684 | 963,043,862 | ..... | 77,403,506 |
| 1872 | 428,487,131 | 15,690,455 | 444,177,586 | 626,595,077 | 1,070,772,663 | ..... | 182,417,491 |
| 1873 | 505,033,439 | 17,446,483 | 522,479,922 | 642,136,210 | 1,164,616,132 | ..... | 119,656,288 |
| 1874 | 569,433,421 | 16,849,619 | 586,283,040 | 567,406,342 | 1,153,689,382 | 18,876,698 | ..... |
| 1875 | 499,284,100 | 14,158,611 | 513,442,711 | 533,005,436 | 1,046,448,147 | ..... | 19,562,725 |
| 1876 | 525,582,247 | 14,802,424 | 540,384,671 | 460,741,190 | 1,001,125,861 | 79,643,481 | ..... |
| 1877 | 589,670,224 | 12,804,996 | 602,475,220 | 451,323,126 | 1,053,798,346 | 151,152,094 | ..... |
| 1878 | 680,709,268 | 14,156,498 | 694,865 766 | 437,051,532 | 1,131,917,298 | 257,814,234 | ..... |
| 1879 | 698,340,790 | 12,098 651 | 710,439 441 | 445,777,775 | 1,156,217,216 | 264,661,666 | ..... |
| 1880 | 823,946,353 | 11,692,305 | 835,638,658 | 667,954,746 | 1,503,593,404 | 167,683,912 | ..... |
| 1881 | 883,925,947 | 18,451,399 | 902,377,346 | 642,664,628 | 1,545,041,974 | 259,712,718 | ..... |
| 1882 | 733,239,732 | 17,302,525 | 750,542,257 | 724,639,574 | 1,475,181,831 | 25,902,683 | ..... |
| 1883 | 804,223,632 | 19,615,770 | 823,839,402 | 723,180,914 | 1,547,020,316 | 100,658,488 | ..... |
| 1884 | 724,964,852 | 15,548,757 | 740,513,609 | 667,697,693 | 1,408,211,302 | 72,815,916 | ..... |
| 1885 | 726,682,946 | 15,506,809 | 742,189,755 | 577,527,329 | 1,319,717,084 | 164,662,426 | ..... |
| 1886 | 665,964,529 | 13,560,301 | 679,524,830 | 635,436,136 | 1,314,960,966 | 44,088,694 | ..... |
| 1887 | 703,022,923 | 13,160,288 | 716,183,211 | 692,319,768 | 1,408,502,979 | 23,863,443 | ..... |
| 1888 | 683,862,104 | 12,092,403 | 695,954,507 | 723,957,114 | 1,419,911,621 | ..... | 28,002,607 |
| 1889 | 730,282,609 | 12,118,766 | 742,401,375 | 745,131,652 | 1,487,533,027 | ..... | 2,730,277 |
| 1890 | 845,293,828 | 12,534,856 | 857,828,684 | 789,310,409 | 1,647,139,093 | 68,518,275 | ..... |
| 1891 | 872,270,283 | 12,210,527 | 884,480,810 | 844,916,196 | 1,729,397,006 | 39,564,614 | ..... |
| 1892 | 1,015,732,011 | 14,546,137 | 1,030,278,148 | 827,402,462 | 1,857,680,610 | 202,875,686 | ..... |
| 1893 | 831,030,785 | 16,634,409 | 847,665,194 | 866,400,922 | 1,714,066,116 | ..... | 18,735,728 |
| 1894 | 869,204,937 | 22,935,635 | 892,140,572 | 654,994,622 | 1,547,135,194 | 237,145,950 | ..... |
| 1895 | 793,392,599 | 14,145,566 | 807,538,165 | 731,969,965 | 1,539,508,130 | 75,568,200 | ..... |
| 1896 | 863,200,487 | 19,406,451 | 882,606,938 | 779,724,674 | 1,662,331,612 | 102,882,264 | ..... |
| 1897 | 1,032,007,603 | 18,985,953 | 1,050,993,556 | 764,730,412 | 1,815,723,968 | 286,263,144 | ..... |
| 1898 | 1,210,291,913 | 21,190,417 | 1,231,482,330 | 616,049,654 | 1,847,531,984 | 615,432,676 | ..... |
| 1899 | 1,203,931,222 | 23,092,080 | 1,227,023,302 | 697,148,489 | 1 924,171,791 | 529,874,813 | ..... |
| 1900 | 1,370,763,571 | 23,719,511 | 1,394,483,082 | 849,941,184 | 2,244,424,266 | 544,541,898 | ..... |
| 1901 | 1,460,462,806 | 27,302,185 | 1,487,764,991 | 823,172,165 | 2,310,937,156 | 664,592,826 | ..... |
| 1902 | 1,355,481,861 | 26,237,540 | 1,381,719,401 | 903,320 948 | 2,285,040.349 | 478,398,453 | ..... |
| 1903 | 1,392,231,302 | 27,910.377 | 1,420,141,679 | 1,025,719,237 | 2,445,860,916 | 394,422,442 | ..... |
| 1904 | 1,435,179,017 | 25,648,254 | 1,460,827,271 | 991,087,371 | 2,451,914,642 | 469,739,900 | ..... |

—Statistical Abstract of the United States.

## UNITED STATES TRADE IN 1904.

By Hon. O. P. AUSTIN, Chief of the United States Bureau of Statistics.

The commerce of the United States in its fiscal year ending June 30, 1904, was the largest in its history. While the imports of the year were slightly below those of 1903, and the exports slightly below those of 1901, the aggregate of imports and exports exceeded the aggregate of imports and exports in any preceding year.

The total value of imports and exports combined was $2,451,914,642, of which imports amounted to $991,087,371, and exports $1,460,827,171. The imports were larger than in any preceding year except 1903, and the exports larger than in any preceding year except 1901.

The chief characteristics of the export trade of the year were a reduction in exports of breadstuffs and an increase in the exports of manufactures. The chief characteristics of the import trade of the year were a reduction in the importation of manufactured and partially manufactured materials, a maintenance of the importation of manufacturers' raw materials, and an increase in the importation of food-stuffs.

Taking up the export trade of the year, in which European countries are especially interested both as consumers of the surplus food products of the United States and as friendly rivals in the world's markets for manufactures, it may be said that the exportations of products of agriculture fell 20 millions of dollars below those of the preceding year, and manufactures exceeded those of last year by 45 million dollars. The reduction in the exportation of agricultural products occurred almost exclusively in corn and wheat.

The wheat exportations of the year fell off enormously, being but 44 million bushels, against 114 millions in the fiscal year 1903 and 154 millions in the fiscal year 1902. Flour also showed a considerable reduction, the exports of the year amounting to only 17 million barrels, against nearly 20 million barrels in 1903 and nearly 18 millions in 1902. In corn there was also a considerable reduction in exports, the total being 56 million bushels in 1904 against 75 millions in 1903.

This very remarkable reduction in the exportation of breadstuffs has attracted much attention and comment in the press and among economists and students of subjects of this kind, and there is a considerable difference of opinion as to the true cause. With some students of this subject the reduction in exports of wheat is looked upon as due to the unusually large crops in the other wheat-exporting countries of the world—Australia, Argentina, India, and Russia—as well as good crops in the European countries which produce for home consumption. By others the unusual business activity and general prosperity in the United States, and consequently increased home demand, is looked upon as the true explanation. The wheat crop of the United States in 1903 fell but 33 million bushels below that of 1902, so that the falling off of nearly 100 million bushels in exportations of wheat (including flour) cannot be entirely charged to crop shortage, and it is probable that the real explanation of the very large reduction in exportations of breadstuffs is a combination of the three circumstances—first, a slight reduction in production in 1903; second, an unusually large production abroad, and third, an unusually large consumption at home.

These conditions, however, suggest that the tendency in the United States is towards a consumption of its own product, and that it is likely to supply a somewhat smaller proportion of the wheat entering the international markets of the world as the years pass and population increases. Doubtless the productive capacity of the wheat fields of the United States can be greatly increased by the intensive cultivation and treatment now applied to the wheat fields of Europe; but this will be a matter of slow development and will probably only come with the enlarged demand due to increased population.

The reduction in exportation of grain was compensated for in a considerable degree by the increased exportation of cotton, which amounted in value to a larger sum than the cotton exports of any preceding year in the history of the country. This was

due in part to the unusually high prices, while in quantity the figures of the year were above the average of the past decade, but nearly 500 million pounds below those of 1902 and 1903, respectively.

The total quantity of cotton exported during the year was 3,063 million pounds, valued at 370 million dollars, which total exceeded in value that of any preceding year. The average price of the cotton exported during the entire year was above 12 cents per pound, which was far in excess of the usual price, thus making the total value of the year's exports the largest in the history of the country and bringing up the total agricultural exports to within 20 million dollars of those of the preceding year.

It was in manufactures that the largest increase in the year's export movements occurred. The total value of manufactures exported during the year was $452,000,000, against $407,000,000 in the preceding year. This brings the total for 1904 above that of any preceding year, the highest figure in former years having been that of 1900—$433,851,756, while that of the year just ended, according to the preliminary report of the Bureau of Statistics, is $452,445,629. Manufactures formed 31.52 per cent of the total exports; agricultural products for the first time in the history of the export trade fell below 60 per cent of the total exports, being 59.48 per cent, as against 62.72 per cent in 1903, 70.54 per cent in 1898, 73.23 per cent in 1888, and 82.63 per cent in 1881.

This marked change in the relative positions of manufactures and agricultural products in the total export trade of the country is even more noticeable in recent months than is indicated by the figures of the entire year. In the months of June, July, and August, the exports of manufactures for the first time in the history of the country exceeded in value the exports of agricultural products. In July, for example, the exports of manufactures were, in round terms, 40 million dollars, and of agricultural products only 31 millions. In August the exports of manufactures were 42 million dollars and those of agricultural products 36 millions. These conditions, however, may be considered abnormal, due to the small exportations of breadstuffs already alluded to, and to the fact that these two months of July and August fall between the cotton-exporting period of last year and that of the year beginning with the month of September. It can hardly be expected, however, that the coming year will show any material increase in the exportation of wheat unless extraordinarily high prices in Europe should tempt the American producer and dealer to send their wheat abroad, since the crop just harvested falls slightly below that of 1903, which was apparently but little more than sufficient to supply the home demand.

The chief characteristic of the import trade was a material reduction in the importation of manufactured and partially manufactured articles. The class "articles manufactured ready for consumption" fell from 170 million dollars in 1903 to 166 millions in 1904; that entitled "articles of voluntary use, luxuries, etc.," which includes manufactured silks, cotton, laces, tobacco, spirits, diamonds, etc., fell from 147 millions to 132 millions, and the class "articles wholly or partially manufactured for use in manufacturing" fell from 164 millions in 1903 to 136 millions in 1904. This large reduction in the class "articles wholly or partially manufactured for use in manufacturing" is chiefly due to the reduction in the importations of iron and steel. The extraordinary demand for iron and steel for use in the construction of buildings, railways, and many other factors in the business of the country rendered the demand in 1902 and the early part of 1903 greater than the supply, even from the great manufacturing system of the United States. This extraordinary demand, however, was greatly reduced in 1903 and the early part of 1904, and as a consequence the importations of iron and steel for use in a partially manufactured state fell from 51½ million dollars in the fiscal year 1903 to 27 millions in the fiscal year 1904.

This marked reduction in the demand for iron and steel in the latter part of 1903 and the early part of 1904 is an index of the general business conditions which prevailed at that period. During the closing months of 1903 and the early part of 1904 a material depression made itself apparent in business generally—in railroad transportation, in the earnings of railways, in bank deposits, and in the various lines of business activity. By many it was feared that the usual decennial recurrence of business depression, due in many cases to over-produc-

tion and abnormal activities in stock speculation, was at hand; but, fortunately, the experiences of the past few months have dissipated that fear. During the months of July, August, and September a marked improvement in business conditions has been reported from all parts of the country.

This includes greater activity upon the railroads, larger deposits in national and savings banks, greater activity in manufacturing, large importations of material for use in manufacturing and other evidences of a restoration of business prosperity. Much of the depression of the latter part of 1903 and the early part of 1904 was doubtless due in a marked degree to the great fall in values of stocks and other securities which had been forced to abnormally high prices through the speculation resulting from the phenomenal prosperity and business activity which occurred in the years 1900, 1901, and 1902.

Another cause of the great falling-off in demand for iron and steel manufactures was the result of a partial suspension of the building industries, due to numerous strikes by the building trade workers in many cities of the country. Many of these strikes have terminated within the past few months.

From this slight depression which occurred in the latter part of 1903 and the early part of 1904 the country seems now to be thoroughly recovering, and despite the fact that Presidential elections are usually accompanied by business depression, all branches of industry and business show at the present time a marked improvement and promise great activity and prosperity during the coming year.

The effect of the war between Japan and Russia has been perceptible in the Pacific trade of the United States. Its first effect was a marked reduction in the exportation of cotton goods to China. Newchwang and the country tributary to that port of China have been for years the chief market for American cottons in China, and the paralysis of trade in that section, due to the hostilities, was immediately felt in the exports of cotton goods to China.

The total exportation of American cotton cloths to China in the fiscal year ending June 30, 1904, amounted to only 76,886,534 yards, against 277,671,500 yards in the fiscal year 1903 and 335,327,764 yards in the fiscal year 1902. This condition, however, seems to have been but temporary, for the termination of active forces and the consequent hostilities in that immediate section of China was followed by large orders from the Chinese markets for American cotton goods, and the *New York Journal of Commerce*, a leading commercial publication, recently stated that "this demand started suddenly in April last. It has gradually increased, and during July and the latter part of August became so active that all spot supplies and early possible deliveries by the mills were quickly absorbed, and orders have now been placed taxing the capacity of the mills well into next year, some orders being deliverable in March and April on the current basis of prices having been turned down this week." The August report of the Bureau of Statistics also shows a remarkable increase in the exportation of cotton goods to China, the total for the month of August, 1904, being 44,247,094 yards against 4,096,161 yards in the corresponding month of last year.

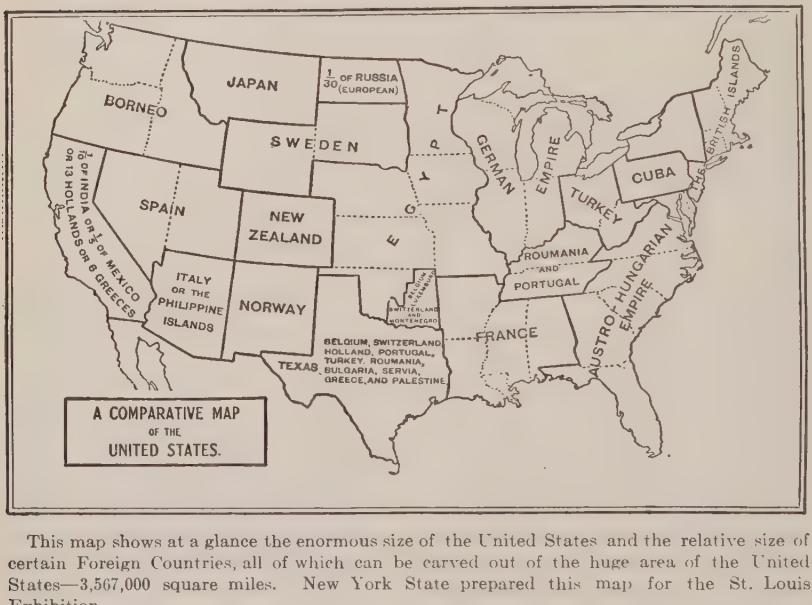
In other lines of merchandise exports to the Orient have not materially decreased and in some instances have increased. The total exports to Japan, which are made up largely of flour, cotton, and machinery, show a marked increase, the total for the fiscal year 1904 being in round terms 25 million dollars, against 21 millions in 1903 and about a like sum in 1902, an increase, therefore, of about 25 per cent in 1904. This is largely due to the exports of flour to Japan, of which the total value in 1904 was $5,140,612, against $2,247,199 in 1903 and $1,279,880 in 1902.

What the final effect of the war in the East will be with reference to American exports in that section of the world can scarcely be foretold. It is a well-recognized fact that Japan is becoming a considerable manufacturer of cotton goods, not only for her own people, but is beginning to export, especially to China, and it seems not improbable that the United States as well as other countries now supplying China with cotton goods may find Japan an active competitor in the early future. It may be expected that that country will further develop its cotton manufacturing industries and prove in China and other parts of the Orient an active competitor of those countries now supplying that market with cotton manufactures.

The records of the fiscal year which ended June 30, 1904, show a total of more than 100 million dollars of commerce between the United States and its non-contiguous territory. Within this term are included Alaska, Porto Rico, the Hawaiian Islands, the Philippine Islands, Guam, Tutuila, etc.

—*Daily Mail Year Book.*

COMPARATIVE AREA OF THE UNITED STATES AND FOREIGN COUNTRIES.




This map shows at a glance the enormous size of the United States and the relative size of certain Foreign Countries, all of which can be carved out of the huge area of the United States—3,567,000 square miles. New York State prepared this map for the St. Louis Exhibition.

ANALYSIS OF THE TRADE OF THE U. S. A.

Imports into the United States.

(According to Continents.) [In millions of dollars.]

| Year. | Europe. | | N. America. | | S. America. | | Asia. | | Oceania. | | Africa. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mills. Dolls. | Per Cent. | Mills. Dolls. | Per Cent. | Mills. Dolls. | Per Cent. | Mills. Dolls. | Per Cent. | Mills. Dolls. | Per Cent. | Mills. Dolls. | Per Cent. |
| 1893 | 458 | 52.91 | 183 | 21.21 | 102 | 11.80 | 87 | 10.11 | 25 | 3.00 | 9 | .97 |
| 1894 | 295 | 45.05 | 166 | 25.49 | 100 | 15.29 | 66 | 10.10 | 21 | 3.28 | 3 | .79 |
| 1895 | 383 | 52.41 | 133 | 18.29 | 112 | 15.32 | 77 | 10.61 | 17 | 2.39 | 5 | .98 |
| 1896 | 418 | 53.69 | 126 | 16.27 | 108 | 13.96 | 89 | 11.49 | 24 | 3.16 | 11 | 1.43 |
| 1897 | 430 | 56.26 | 105 | 13.85 | 107 | 14.04 | 87 | 11.41 | 24 | 3.19 | 9 | 1.25 |
| 1898 | 305 | 40.66 | 91 | 14.83 | 92 | 14.95 | 92 | 15.03 | 26 | 4.36 | 7 | 1.17 |
| 1899 | 353 | 50.76 | 112 | 16.09 | 86 | 12.42 | 107 | 15.36 | 26 | 3.87 | 10 | 1.50 |
| 1900 | 440 | 51.84 | 130 | 15.30 | 93 | 11.02 | 139 | 16.45 | 34 | 4.07 | 11 | 1.32 |
| 1901 | 429 | 52.19 | 145 | 17.63 | 110 | 13.41 | 117 | 14.30 | 11 | 1.38 | 8 | 1.09 |
| 1902 | 475 | 52.61 | 151 | 16.73 | 119 | 13.26 | 129 | 14.35 | 14 | 1.57 | 13 | 1.48 |
| 1903 | 550 | 53.63 | 188 | 18.42 | 107 | 10.47 | 145 | 14.21 | 21 | 2.05 | 12 | 1.22 |

Exports from the U. S. A.
(According to Continents).

| Year. | Europe. | | N. America. | | S. America. | | Asia. | | Oceania. | | Africa. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mills. Dolls. | Per Cent. | Mills. Dolls. | Per Cent. | Mills. Dolls. | Per Cent. | Mills. Dolls. | Per Cent. | Mills. Dolls. | Per Cent. | Mills. Dolls. | Per Cent. |
| 1893 | 661 | 78.10 | 119 | 14.13 | 32 | 3.85 | 16 | 1.91 | 11 | 1.32 | 5 | .69 |
| 1894 | 700 | 78.57 | 119 | 13.42 | 33 | 3.72 | 20 | 2.34 | 11 | 1.34 | 4 | .61 |
| 1895 | 627 | 77.76 | 108 | 13.45 | 33 | 4.15 | 17 | 2.15 | 13 | 1.62 | 6 | .87 |
| 1896 | 673 | 76.26 | 116 | 13.21 | 36 | 4.11 | 25 | 2.90 | 17 | 1.95 | 13 | 1.57 |
| 1897 | 813 | 77.39 | 124 | 11.89 | 33 | 3.21 | 39 | 3.74 | 22 | 2.16 | 16 | 1.61 |
| 1898 | 973 | 79.07 | 139 | 11.35 | 33 | 2.75 | 44 | 3.63 | 22 | 1.78 | 17 | 1.42 |
| 1899 | 936 | 76.33 | 157 | 12.87 | 35 | 2.91 | 48 | 3.94 | 29 | 2.43 | 18 | 1.52 |
| 1900 | 1,040 | 74.60 | 187 | 13.45 | 38 | 2.79 | 64 | 4.66 | 43 | 3.11 | 19 | 1.79 |
| 1901 | 1,136 | 76.39 | 196 | 13.21 | 44 | 2.98 | 49 | 3.34 | 35 | 2.36 | 25 | 1.72 |
| 1902 | 1,008 | 72.96 | 203 | 14.75 | 38 | 2.76 | 63 | 4.63 | 34 | 2.48 | 33 | 2.42 |
| 1903 | 1,029 | 72.49 | 215 | 15.18 | 41 | 2.89 | 57 | 4.09 | 37 | 2.64 | 38 | 2.71 |

Exports of Domestic Merchandise from the U. S. A., 1893 to 1903.
(According to classes.)

| Year ending June 30. | Manufactures. | | Agricultural Products. | | Products of the Mines. | | Products of the Forests. | | Products of the Fisheries. | | Miscellaneous Products. | | Total. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mills. Dolls. | Per Cent. | Mills. Dolls. | Per Cent. | Mills. Dolls. | Per Cent. | Mills. Dolls. | Per Cent. | Mills. Dolls. | Per Cent. | Mills. Dolls. | Per Cent. | Mills. Dolls. |
| 1893 | 158 | 19.02 | 615 | 74.05 | 20 | 2.41 | 28 | 3.38 | 5 | .67 | 3 | .47 | 831 |
| 1894 | 183 | 21.14 | 628 | 72.28 | 20 | 2.35 | 28 | 3.22 | 4 | .49 | 4 | .52 | 869 |
| 1895 | 183 | 23.14 | 553 | 69.73 | 18 | 2.33 | 28 | 3.61 | 5 | .67 | 4 | .52 | 793 |
| 1896 | 228 | 26.48 | 569 | 66.02 | 20 | 2.32 | 33 | 3.91 | 6 | .79 | 4 | .48 | 863 |
| 1897 | 277 | 26.87 | 683 | 66.23 | 20 | 2.01 | 40 | 3.92 | 6 | .63 | 3 | .34 | 1,032 |
| 1898 | 290 | 24.02 | 853 | 70.54 | 19 | 1.60 | 37 | 3.13 | 5 | .45 | 3 | .26 | 1,210 |
| 1899 | 339 | 28.21 | 784 | 65.19 | 28 | 2.34 | 42 | 3.49 | 5 | .50 | 3 | .27 | 1,203 |
| 1900 | 433 | 31.65 | 835 | 60.98 | 37 | 2.76 | 52 | 3.81 | 6 | .46 | 4 | .34 | 1,370 |
| 1901 | 412 | 28.22 | 943 | 64.62 | 37 | 2.60 | 54 | 3.72 | 7 | .53 | 4 | .31 | 1,460 |
| 1902 | 403 | 29.77 | 851 | 62.83 | 39 | 2.90 | 48 | 3.55 | 7 | .57 | 5 | .38 | 1,355 |
| 1903 | 408 | 29.32 | 873 | 62.72 | 38 | 2.79 | 57 | 4.15 | 7 | .56 | 6 | .46 | 1,392 |

Imports into the U. S. A., 1893 to 1903.
(According to classes.)

| Year ending June 30 | Food and Live Animals. | | Crude Articles for Domestic Industries. | | Articles Wholly or Partially Manufactured for Use as Materials in Mechanic Arts. | | Articles Manufactured Ready for Consumption. | | Luxuries, and other Articles of Voluntary Use. | | Total. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mills. Dolls. | Per Cent. | Mills. Dolls. | Per Cent. | Mills. Dolls. | Per Cent. | Mills. Dolls. | Per Cent. | Mills. Dolls. | Per Cent. | Mills. Dolls. |
| 1893 | 269 | 31.89 | 218 | 25.85 | 94 | 11.20 | 153 | 18.22 | 108 | 12.84 | 844 |
| 1894 | 275 | 43.33 | 126 | 19.89 | 65 | 10.32 | 99 | 15.60 | 69 | 10.86 | 636 |
| 1895 | 226 | 30.97 | 187 | 25.64 | 83 | 11.46 | 140 | 19.25 | 92 | 12.68 | 731 |
| 1896 | 228 | 30.13 | 201 | 26.57 | 79 | 10.46 | 160 | 21.09 | 89 | 11.75 | 759 |
| 1897 | 254 | 32.27 | 207 | 26.26 | 69 | 8.85 | 165 | 20.91 | 92 | 11.72 | 789 |
| 1898 | 170 | 29.08 | 188 | 32.16 | 58 | 9.91 | 94 | 16.15 | 74 | 12.70 | 587 |
| 1899 | 207 | 30.27 | 218 | 31.82 | 60 | 8.76 | 110 | 16.15 | 89 | 13.00 | 685 |
| 1900 | 216 | 26.02 | 299 | 36.04 | 80 | 9.70 | 130 | 15.72 | 103 | 12.51 | 830 |
| 1901 | 213 | 26.45 | 270 | 33.54 | 74 | 9.27 | 135 | 16.81 | 112 | 13.93 | 807 |
| 1902 | 201 | 22.26 | 327 | 36.27 | 91 | 10.09 | 150 | 16.66 | 132 | 14.72 | 903 |
| 1903 | 218 | 21.18 | 375 | 36.58 | 114 | 11.15 | 170 | 16.61 | 147 | 14.38 | 1,025 |

—Daily Mail Year Book.

## IMPORTS OF MERCHANDISE, BY PRINCIPAL ARTICLES AND CLASSES, IN ORDER OF MAGNITUDE IN 1904.

| Articles. | 1904. | Articles. | 1904. |
|---|---|---|---|
| | Dollars. | | Dollars. |
| Sugar | 71,915,753 | Vegetables | 7,008,602 |
| Coffee | 69,551,799 | Glass and glassware | 6,583,168 |
| Chemicals, drugs, and dyes | 65,294,558 | Paper, and manufactures of | 5,319,086 |
| Hides and skins | 52,006,070 | Coal, bituminous | 5,043,824 |
| Cotton, manufactures of | 49,524,246 | Toys | 4,977,389 |
| Silk, unmanufactured | 46,100,500 | Books, maps, engravings, etc | 4,529,187 |
| India rubber and gutta-percha, crude | 41,049,434 | Spices | 4,366,008 |
| Fibers, vegetable, etc., manufactures of | 40,308,837 | Provisions: Meat and dairy products | 4,197,466 |
| Fibers, vegetable, etc., unmanufactured | 37,814,285 | Hats, bonnets, and hoods, and materials for | 3,963,043 |
| Silk, manufactures of | 31,973,680 | Matting, for floors, etc | 3,609,795 |
| Iron and steel, and manufactures of | 27,028,312 | Seeds | 3,587,469 |
| Wood and manufactures of | 26,984,353 | Fertilizers | 3,503,726 |
| Wool, unmanufactured | 24,813,591 | Copper ore | 3,466,381 |
| Fruits and nuts | 24,435,854 | Lead, in ore | 3,374,661 |
| Diamonds and other precious stones | 22,964,119 | Art works | 3,286,262 |
| Tin, in bars, blocks, or pigs | 21,486,311 | Breadstuffs | 3,247,503 |
| Tobacco, and manufactures of | 20,073,346 | Animals | 3,129,609 |
| Tea | 18,229,310 | Rice | 3,073,430 |
| Copper, and manufactures of | 18,215,442 | Household and personal effects | 3,040,523 |
| Wool, manufactures of | 17,733,788 | Clocks and watches, and parts of | 2,990,474 |
| Spirits, malt liquors, and wines | 16,662,702 | Paper stock, crude | 2,900,713 |
| Furs, and manufactures of | 14,763,002 | Feathers and downs, crude, not dressed, etc | 2,742,018 |
| Earthen, stone, and china ware | 12,005,014 | Hair, and manufactures of | 2,727,062 |
| Oils | 11,179,442 | Bristles | 2,367,301 |
| Leather, and manufactures of | 11,100,215 | Cork wood, or cork bark, and manuafctures of | 2,295,138 |
| Articles, the growth, etc., of the United States, returned | 9,899,470 | Cement | 2,052,952 |
| Fish | 9,889,697 | Jewelry, and manufactures of gold and silver | 2,048,821 |
| Cocoa, crude, and leaves and shells of | 8,873,709 | Iron ore | 1,593,279 |
| Cotton, unmanufactured | 8,541,510 | Hay | 914,842 |
| Metals, and manufactures of | *7,092,125 | All other articles | 51,637,165 |
| | | Total | 991,087,371 |

* Includes "Bronze, manufactures of."

—*Foreign Commerce and Navigation Bureau of Statistics.*

## MOTIVE-POWER APPLIANCES.

By Edward H. Sanborn, Expert Special Agent Twelfth Census.

The 1,170 establishments covered by the report produced during the census year 40,533 steam boilers, representing an aggregate of 2,928,983 horsepower, with a total value of $25,663,445. Of steam engines of all types there were manufactured 29,120, representing 2,210,727 horsepower, and valued at $28,019,971. The number of internal-combustion engines, using gas, petroleum, or other vapors, produced by these establishments was 18,531, their aggregate horsepower was 164,662, and their total value amounted to $5,579,398. There were also manufactured 2,680 water motors, including overshot and undershot wheels, turbines, and impact wheels, with an estimated total of 367,934 horsepower, and an aggregate value of $1,520,849. The totals for all primary powers, exclusive of steam boilers, were as follows: Number of units, 50,331; aggregate horsepower, 2,743,323; total value, $35,120,218. The other products of these 1,170 establishments amounted in value to $84,754,239; the amounts received for custom work and repairing reached a total of $26,664,243, and the total output of all products and all classes of work represented a value of $172,202,145.

The table shows the number, aggregate horsepower, and total value of each kind of motive-power appliances produced by these establishments during the census year.

NUMBER, AGGREGATE HORSEPOWER, AND VALUE OF PRIMARY POWERS: 1900.

| | |
|---|---|
| Number of establishments | 1,170 |
| Steam boilers: | |
| Fire tube— | |
| Number | 35,802 |
| Aggregate horsepower | 1,943,222 |
| Total value | $18,037,451 |
| Water tube— | |
| Number | 4,731 |
| Aggregate horsepower | 985,761 |
| Total value | $7,625,994 |
| Steam engines: | |
| Marine— | |
| Number | 767 |
| Aggregate horsepower | 396,047 |
| Total value | $7,018,369 |
| Fixed cut-off throttling— | |
| Number | 21,806 |
| Aggregate horsepower | 658,111 |
| Total value | $7,963,805 |
| High speed variable automatic cut-off— | |
| Number | 3,823 |
| Aggregate horsepower | 314,668 |
| Total value | $3,282,787 |
| Low speed variable automatic cut-off— | |
| Number | 2,724 |
| Aggregate horsepower | 841,901 |
| Total value | $9,755,010 |
| Internal-combustion engines: | |
| Number | 18,531 |
| Aggregate horsepower | 164,662 |
| Total value | $5,579,398 |
| Overshot or undershot water wheels: | |
| Number | 58 |
| Aggregate horsepower | 1,257 |
| Total value | $12,250 |
| Turbine water wheels: | |
| Number | 1,665 |
| Aggregate horsepower | 311,527 |
| Total value | $1,232,090 |
| Impact water wheels: | |
| Number | 957 |
| Aggregate horsepower | 55,150 |
| Total value | $276,509 |
| Primary powers, all kinds: | |
| Number | 50,331 |
| Aggregate horsepower | 2,743,323 |
| Total value | $35,120,218 |

## POWER, COMPARATIVE SUMMARY: 1870 TO 1900.

[Twelfth Census, Vol. VII, pages cccxvi, and 582.]

| Power. | Date of Census. | | | | Per Cent. of Increase. | | |
|---|---|---|---|---|---|---|---|
| | 1900. | 1890. | 1880. | 1870. | 1890 to 1900. | 1880 to 1890. | 1870 to 1880. |
| Total number of establishments. | 512,191 | 355,405 | 253,852 | 252,148 | 44.1 | 40.0 | 0.7 |
| Total number of establishments reporting power. | 169,364 | 100,726 | 85,923 | [1] | 68.1 | 17.2 | ..... |
| Per cent of establishments reporting power to total number. | 33.1 | 28.3 | 33.8 | ..... | ..... | ..... | ..... |
| Total horsepower. | 11,298,119 | 5,954,204 | 3,410,837 | 2,346,142 | 89.8 | 74.6 | 45.4 |
| Average horsepower per establishment. | 66.7 | 59.1 | 39.7 | [2] 9.3 | 12.9 | 48.9 | [3] 26.9 |
| Steam engines: | | | | | | | |
| Number. | 156,051 | 91,403 | 56,483 | [1] | 70.7 | 61.8 | ..... |
| Horsepower. | 8,741,338 | 4,581,305 | 2,185,458 | 1,215,711 | 90.8 | 109.6 | 79.8 |
| Per cent of total horsepower. | 77.4 | 76.9 | 64.1 | 51.8 | ..... | ..... | ..... |
| Gas engines: | | | | | | | |
| Number | 14,884 | [1] | [1] | [1] | ..... | ..... | ..... |
| Horsepower. | 143,850 | 8,930 | [1] | [1] | 1,510.9 | ..... | ..... |
| Per cent of total horsepower. | 1.3 | 0.1 | ..... | ..... | ..... | ..... | ..... |
| Water wheels: | | | | | | | |
| Number | 39,168 | 39,005 | 55,404 | [1] | 0.4 | [3] 29.6 | ..... |
| Horsepower. | 1,726,661 | 1,255,045 | 1,225,379 | 1,130,431 | 37.6 | 2.4 | 8.4 |
| Per cent of total horsepower. | 15.3 | 21.1 | 35.9 | 48.2 | ..... | ..... | ..... |
| Electric motors: | | | | | | | |
| Number. | 16,912 | [1] | [1] | [1] | ..... | ..... | ..... |
| Horsepower. | 310,729 | 15,569 | [1] | [1] | 1,895.8 | ..... | ..... |
| Per cent of total horsepower. | 2.8 | 0.3 | ..... | ..... | ..... | ..... | ..... |
| Other power: | | | | | | | |
| Number. | 2,144 | [1] | [1] | [1] | ..... | ..... | ..... |
| Horsepower. | 54,490 | 4,784 | [1] | [1] | 1,039.0 | ..... | ..... |
| Per cent of total horsepower. | 0.5 | 0.1 | ..... | ..... | ..... | ..... | ..... |
| Total rented horsepower. | 321,051 | 88,571 | [1] | [1] | 262.5 | ..... | ..... |
| Per cent of total horsepower. | 2.8 | 1.5 | ..... | ..... | ..... | ..... | ..... |
| Electric rented horsepower. | 183,682 | [4] | [1] | [1] | ..... | ..... | ..... |
| All other rented horsepower. | 137,369 | [4] | [1] | [1] | ..... | ..... | ..... |

[1] Not reported. [2] Average for all establishments. [3] Decrease. [4] Not reported separately

## METAL-WORKING MACHINERY IN THE UNITED STATES—KIND, QUANTITY, AND VALUE OF PRODUCTS: 1900.

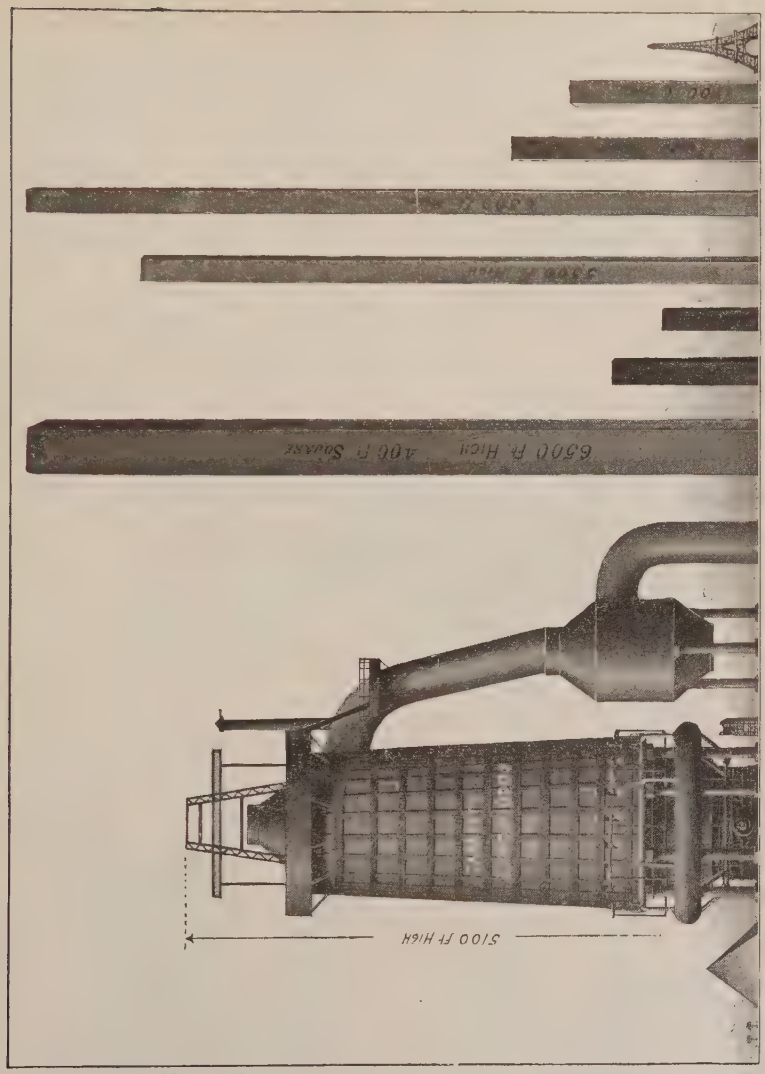
| | |
|---|---|
| Number of establishments reporting | 397 |
| Hammers—steam, power, and drop: | |
| Number | 857 |
| Value | $671,287 |
| Forging machines, including bolt headers, and all other machines for forging hot metal with dies and by pressure: | |
| Number | 821 |
| Value | $424,774 |
| Stamping, flanging, and forming machines for plate and sheet metal: | |
| Number | 7,895 |
| Value | $1,180,960 |
| Punching and shearing machines: | |
| Number | 5,269 |
| Value | $1,219,605 |
| Bending and straightening rolls: | |
| Number | 914 |
| Value | $202,230 |
| Riveting machines: | |
| Number | 202 |
| Value | $139,295 |
| Lathes: | |
| Hand— | |
| Number | 3,945 |
| Value | $306,081 |
| Engine— | |
| Number | 12,089 |
| Value | $4,451,867 |
| Turret, including all automatic or semi-automatic lathes for making duplicate pieces— | |
| Number | 3,687 |
| Value | $2,449,121 |
| Boring and turning mills or vertical lathes: | |
| Number | 534 |
| Value | $1,123,314 |
| Boring and drilling machinery, including all machines using drills or boring bars: | |
| Number | 22,890 |
| Value | $2,779,983 |
| Planers, including plate-edge planers: | |
| Number | 1,543 |
| Value | $1,808,955 |
| Slotters and shapers: | |
| Number | 3,076 |
| Value | $1,136,350 |
| Milling machines, including all machines using a milling cutter: | |
| Number | 4,119 |
| Value | $2,171,966 |
| Sawing machines: | |
| Number | 2,846 |
| Value | $222,563 |
| Grinding and polishing machinery, including all machines using abrasive cutters: | |
| Number | 10,014 |
| Value | $880,965 |
| Bolt, nut, and pipe threading and tapping machines: | |
| Number | 2,088 |
| Value | $698,362 |
| Pneumatic hand tools: | |
| Number | 6,751 |
| Value | $143,325 |
| All other metal working machines, value | $2,726,901 |
| All other products, value | $16,375,956 |
| Amount received for custom work and repairing | $3,271,369 |
| Total value of all products | $44,385,229 |

—U. S. Census Bulletin.

## OUR IRON AND STEEL PRODUCTION.

The statement that in 1902 forty per cent. of the pig iron in the world was produced in the United States gives one no very definite realization of the quantity of that product, though he be reminded on every hand by iron and steel ships, bridges, railroads, buildings, machinery, tools, nails, tacks, etc., *ad nauseam*, that this is the iron age. Even the statement that the United States last year mined over thirty million long tons of iron ore gives one no adequate impression of the vastness of this amount. On the other hand, if one should see the entire iron ore production of the year piled up in a single heap, he would readily comprehend this quantity by a comparison of the pile with familiar objects in the landscape. This shows us that it is large numbers instead of large quantities which confuse the mind; for example, the statement that a wagon holds over 30,000,000 grains of coal would give a person a very hazy idea of the actual quantity specified, but he would immediately comprehend the quantity if told that it represented two tons; for a larger unit of weight would be used, thereby reducing the count to a figure well within the mental grasp. Thus in trying to represent to our readers just how large are the quantities of materials used in the iron and steel industry, we have endeavored to choose larger units of measurement; and finding that our standard measures are far too small for the purpose, we have resorted to the use of familiar landmarks as bases of comparison.

As a unit of bulk, no larger single


1—Great Pyramid. 2—Blast Furnace. 3—Park Row Building. 4—Coke. 5—Coal. 6—Charcoal. 7—Limestone. 8—Iron Ore.
9—Pig Iron. 10—Steel. 11—Eiffel Tower.

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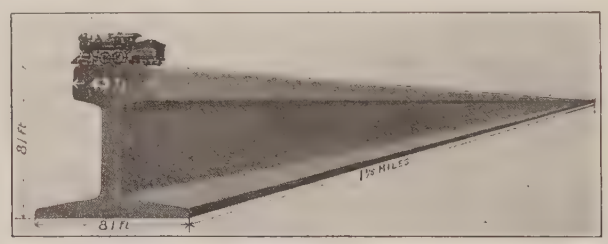
COMPARATIVE DIAGRAM SHOWING THE TOTAL ANNUAL AMOUNT OF RAW MATERIALS OF THE IRON AND STEEL INDUSTRY IN THE UNITED STATES, AS COMPARED WITH THE FINISHED PRODUCTS SHOWN ON PAGES 296, 297 AND 298.

monument has man produced than the old pyramid of Cheops, and large though it be, it is all too small when used as a unit by which to measure the stupendous volume of material used in our pig-iron production of a single year. In the accompanying illustration, the huge blast furnace shown at the left represents a furnace which would receive at a single charge all our iron ore production during the year 1902, together with the fuel and limestone used. The charge measures approximately two billion cubic feet, or to use our proposed unit of bulk, this would be equivalent to twenty-four pyramids. As many individuals may have formed no adequate conception of the size of the Great Pyramid, we have used as an additional basis of comparison the tallest building in the world, namely, the Park Row Building in New York. This building measures 390 feet in height, and it would require thirteen such buildings placed one above the other, to equal the height of our hypothetical blast furnace.

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PROPORTION OF FINISHED PRODUCTS FORMED INTO RAIL.

### FUEL.

Of the contents of the blast furnace by far the larger bulk is fuel, though the weight of the iron ore is almost twice that of the fuel. The square columns in our illustration will serve to give one some idea of the amount of fuel which was consumed in 1902 by the blast furnaces of the United States. A fair estimate would be about 16,000,000 tons of coke, 1,600,000 tons of coal, and 300,000 tons of charcoal. Coke is so light that if the 16,000,000 tons were built up in a column 400 feet square, the column would reach an altitude of 6,500 feet. No human monument is large enough to give us, by comparison with this column, any idea of such a height. If the base of the column were situated at sea level, a person at the top could look down on the summit of Mount Washington, N. H., and it would overtop every mountain in this country east of the Rockies.

Our column of coal includes both anthracite and bituminous. In the last two years there has been a considerable falling off in the use of anthracite, while bituminous coal mixed with coke has shown a great increase over former years, so that our column would probably be made up of two parts bituminous to one part anthracite coal. Their combined bulk would form a column 200 feet square by 1,300 feet high—a midget in comparison to the coke column, but not so small after all when compared with the Park Row Building.

Charcoal, which is the smallest item in the fuel statistics for 1902, or about one-fifth of the number of tons of coal, yet forms a column nearly two-thirds the height of the coal column, or twice that of the Park Row Building.

### FLUX.

The amount of limestone used for fluxing purposes last year amounted to 9,490,090 tons. This would make a column 5,500 feet high, with a cross-section 200 feet square. It may be interesting to note here that oyster shells are used in one of the furnaces in Maryland in place of limestone.

IRON ORE.

The next column, which is of a height equal to that of the coke column, is composed of 34,636,121 tons of iron ore. However, this represents in bulk only one-quarter that of the coke.

PIG IRON.

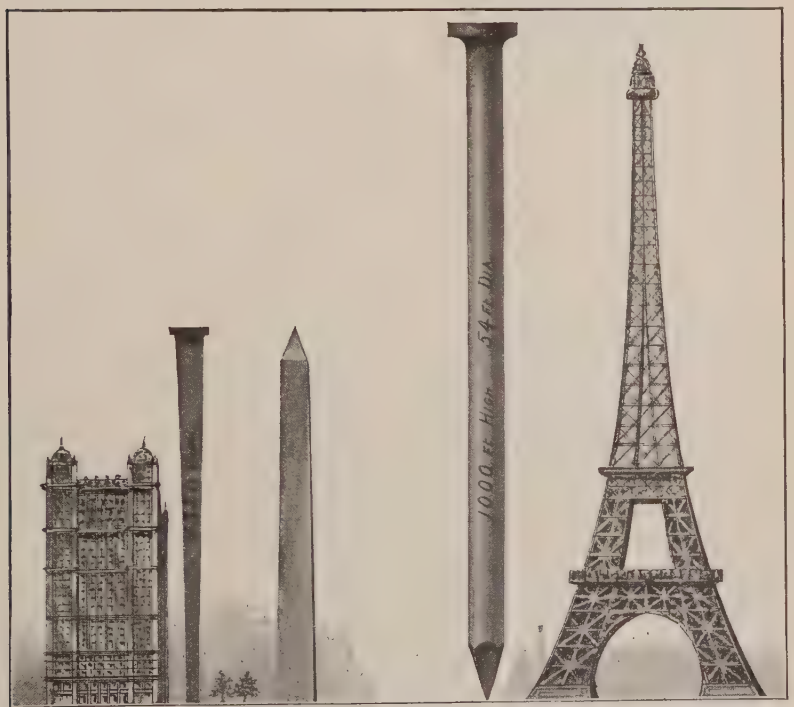
All the above-mentioned materials were used last year to produce 17,821,307 tons of pig iron. This makes a column twice the height of the Eiffel Tower, the tallest monument to human skill in the world.

STEEL.

The larger part of the pig iron production of this country is converted into steel; 14,947,250 tons represent the total output for last year. Of this, 9,138,363 tons were made by the Bessemer process, 5,687,729 by the open-hearth process, and 121,158 tons were crucible steel.

FINISHED PRODUCTS.

Of the finished products for the year, 2,947,933 tons represent the amount of iron and steel formed into rails. If all this metal were rolled into a single rail of standard proportions, it would measure approximately 81 feet high, and would be about a mile and one-fifth long. The base would, of course, equal the height, and the tread would have a width of 43 feet. In our

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Park Row Building. Cut Nail. Washington Monument. Wire Nail. Eiffel Tower.

PROPORTION OF FINISHED PRODUCTS FORMED INTO WIRE NAILS AND CUT NAILS.

illustration we have shown the relative proportions of a locomotive of average size placed on this rail.

Next in quantity to the iron and steel rail production is last year's output of plates and sheets; 2,665,409 tons of metal were thus converted. This amount, if rolled into a single sheet of No. 30 standard gage, which is the thinnest sheet steel commercially used, would cover 420 square miles, or nearly twenty times the area of the island of Manhattan. The extent of this area is illustrated in the accompanying sketch plan of New York city and its vicinity.

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PROPORTION OF FINISHED PRODUCTS FORMED INTO PLATES AND SHEETS.

The production of nails forms no small part of the finished products for the year. Wire nails represent, of course, a much larger part of the output. The totals are 10,982,246 100-pound kegs of wire nails and 1,633,762 100-pound kegs of cut nails. Following the method in our two previous comparisons, we have represented each amount by a single nail of standard proportions. The cut nail would tower far above the Park Row Building, measuring almost exactly the height of the Washington Monument, while the wire nail would rise to nearly double this height, overtopping the Eiffel Tower, and forming a solid column of metal 54 feet in diameter and 1,000 feet high.

## CARRIAGES AND WAGONS.

The manufacture of carriages and wagons has been carried on in the United States practically since the time of the early settlers. In the Census year 1900 there were 7,632 establishments, having a capital of $118,187,838. The industry gave employment to 66,842 persons (officials, clerks, wage-earners) and the salaries and wages were $33,888,843. The cost of materials used was $56,676,073. The value of products, including custom work and repairing, was $121,537,276. The increase in product of the Census year 1900 over Census year 1890 was $18,856,935.

The trend of the industry is toward the Central States, where land is cheaper, where suitable lumber is abundant and prices are therefore favorable, and where also the developed railroad systems afford abundant means of transportation. The same rapid development of the industry is seen in certain of the Southern States, such as North Carolina, Tennessee and Virginia, where lumber is cheap and where manufactures are fast gaining industrial predominance. The increase in Massachusetts, New Jersey, New York and Pennsylvania is due partly to the growing use of the automobile, to the diminishing use of the bicycle, and materially to the more perfect segregation of the "factory product" and that formerly classed as "custom work and repairing."

## PHONOGRAPHS AND TALKING MACHINES.

In 1900 there were eleven establishments engaged in the manufacture of phonographs and other talking machines. The capital invested was $3,348,282, and the industry gave employment to 1,267 wage-earners and 144 salaried officials and clerks. The value of the product was $2,246,274. The number of completed machines was 151,403, the number of horns, 28,423, and the number of records produced was 2,763,277.

VALUE OF EXPORTS OF AGRICULTURAL IMPLEMENTS, 1896 TO 1900, INCLUSIVE.

| Countries and Classes. | 1896. | 1897. | 1898. | 1899. | 1900. |
|---|---|---|---|---|---|
| Aggregate | $5,176,775 | $5,240,686 | $7,609,732 | $12,432,197 | $16,099,149 |
| Mowers, reapers, and parts of same: Total. | 3,212,423 | 3,127,415 | 5,500,665 | 9,053,830 | 11,243,763 |
| France | 360,577 | 494,469 | 1,146,551 | 1,678,865 | 2,652,795 |
| Germany | 480,773 | 538,430 | 1,100,210 | 1,503,968 | 2,529,422 |
| Russia | 387,316 | 265,442 | 409,368 | 863,476 | 710,066 |
| United Kingdom | 333,791 | 360,079 | 874,296 | 1,040,059 | 982,188 |
| Canada | 132,945 | 248,359 | 440,878 | 934,962 | 1,192,458 |
| Argentina | 570,332 | 228,391 | 182,283 | 1,074,749 | 1,194,961 |
| British Australasia | 195,533 | 302,586 | 421,975 | 358,862 | 466,397 |
| All other countries | 751,156 | 689,659 | 925,104 | 1,598,889 | 1,515,476 |
| Plows, cultivators, and parts of same: Total. | 746,604 | 590,779 | 927,250 | 1,545,410 | 2,178,098 |
| France | 15,048 | 7,992 | 49,330 | 59,105 | 68,197 |
| Germany | 6,402 | 11,206 | 15,450 | 38,898 | 227,378 |
| Russia | 23,777 | 3,129 | 29,566 | 14,902 | 45,993 |
| United Kingdom | 43,105 | 36,142 | 74,763 | 69,737 | 179,950 |
| Canada | 40,533 | 73,023 | 182,809 | 207,480 | 247,306 |
| Argentina | 161,347 | 104,072 | 151,737 | 440,996 | 388,903 |
| British Australasia | 32,450 | 39,527 | 108,116 | 166,035 | 162,109 |
| All other countries | 423,942 | 315,688 | 315,479 | 548,257 | 858,262 |
| All other implements, and parts of same: Total. | 1,217 748 | 1,522,492 | 1,181,817 | 1,832,957 | 2,677,288 |
| France | 91,359 | 121,495 | 56,286 | 43,689 | 189,583 |
| Germany | 94,552 | 161,182 | 116,582 | 103,845 | 129,654 |
| Russia | 65,236 | 253,495 | 19,653 | 59,848 | 271,671 |
| United Kingdom | 211,654 | 246,096 | 195,966 | 262,597 | 188,305 |
| Canada | 186,166 | 143,455 | 157,728 | 378,612 | 571,442 |
| Argentina | 122,488 | 82,849 | 43,034 | 163,274 | 221,880 |
| British Australasia | 57,739 | 148,872 | 167,474 | 243,775 | 269,776 |
| All other countries | 388.554 | 365,048 | 425,094 | 577,317 | 834,977 |

—United States Treasury Department: Report on Commerce and Navigation, 1900.

VALUE OF IMPLEMENTS ON FARMS, BY STATES AND TERRITORIES, 1900.

| States and Territories. | Value of Implements on Farms. | States and Territories. | Value of Implements on Farms. |
|---|---|---|---|
| United States | $749,776,660 | Missouri | $23,602,680 |
| | | Montana | 3,671,900 |
| Alabama | $8,675,900 | Nebraska | 24,940,450 |
| Alaska | 690 | Nevada | 888,560 |
| Arizona | 765,200 | New Hampshire | 5,163,090 |
| Arkansas | 8,750,060 | New Jersey | 9,330,030 |
| California | 21,311,670 | New Mexico | 1,151,610 |
| Colorado | 4,746,755 | New York | 56,006,000 |
| Connecticut | 4,948,300 | North Carolina | 9,072,600 |
| Delaware | 2,150,560 | North Dakota | 14,055,560 |
| District of Columbia | 136,060 | Ohio | 36,354,150 |
| Florida | 1,963,210 | Oklahoma | 6,573,015 |
| Georgia | 9,804,010 | Oregon | 6,506,725 |
| Idaho | 3,295,045 | Pennsylvania | 50,917,240 |
| Illinois | 44,977,310 | Rhode Island | 1,270,270 |
| Indiana | 27,330,370 | South Carolina | 6,629,770 |
| Indian Territory | 3,939,480 | South Dakota | 12,218,680 |
| Iowa | 57,960,660 | Tennessee | 15,232,670 |
| Kansas | 29,490,580 | Texas | 30,125,705 |
| Kentucky | 15,301,860 | Utah | 2,922,550 |
| Louisiana | 28,536,790 | Vermont | 7,538,490 |
| Maine | 8,802,720 | Virginia | 9,911,040 |
| Maryland | 8,611,220 | Washington | 6,271,630 |
| Massachusetts | 8,828,950 | West Virginia | 5,040,420 |
| Michigan | 28,795,380 | Wisconsin | 29,237,010 |
| Minnesota | 30,099,230 | Wyoming | 1,366,000 |
| Mississippi | 9,556,805 | | |

## SUMMARY OF PROGRESS OF THE UNITED STATES

Compiled from "Territorial and Commercial Expansion of the United States."

| Area, Population, and Industries. | In | 1800. | 1850. |
|---|---|---|---|
| AREA AND POPULATION: | | | |
| Area[1] | Sq. miles... | 827,844 | 2,980,959 |
| Population [2] | Number... | 5,308,483 | 23,191,876 |
| Per square mile [2] | Number... | 6.41 | 7.78 |
| WEALTH: | | | |
| Total [3] | Dollars.... | ..... | 7,135,780,000 |
| Per capita | Dollars.... | ..... | 307.69 |
| PUBLIC-DEBT STATEMENT: | | | |
| Public debt, less cash in the Treasury [5] | Dollars.... | 82,976,294.35 | 63,452,773.55 |
| Per capita, less cash in Treasury | Dollars.... | 15.63 | 2.74 |
| Interest-bearing debt [6] | Dollars.... | 82,976,294 | 63,452,774 |
| Annual interest charge | Dollars.... | 3,402,601 | 3,782,393 |
| Per capita | Dollars.... | 0.64 | 0.16 |
| COINAGE: | | | |
| Gold coined | Dollars.... | 317,760 | 31,981,739 |
| Silver coined | Dollars.... | 224,296 | 1,866,100 |
| Commercial ratio of silver to gold | Dollars.... | 15.68 | 15.70 |
| MONEY IN CIRCULATION: | | | |
| Gold in circulation [7] | Dollars.... | [8] 16,000,000 | [8] 147,395,456 |
| Silver in circulation [7] | | | |
| Gold certificates in circulation | Dollars.... | ..... | ..... |
| Silver certificates in circulation | Dollars.... | ..... | ..... |
| United States notes (greenbacks) in circulation | Dollars.... | ..... | ..... |
| National-bank notes in circulation (October 31) | Dollars.... | ..... | ..... |
| Miscellaneous currency in circulation [9] | Dollars.... | 10,500,000 | 131,366,526 |
| Total money in circulation | Dollars.... | 26,500,000 | 278,761,982 |
| Per capita | Dollars.... | 5.00 | 12.02 |
| NATIONAL BANKS: | | | |
| Reporting nearest June 30 | Number... | ..... | ..... |
| Capital | Dollars.... | ..... | ..... |
| Loans and discounts | Dollars.... | ..... | ..... |
| BANK CLEARINGS: | | | |
| New York | Dollars.... | ..... | ..... |
| Total United States | Dollars.... | ..... | ..... |
| BANK DEPOSITS: | | | |
| National banks (individual) | Dollars.... | ..... | ..... |
| Savings banks | Dollars.... | ..... | 43,431,130 |
| State banks | Dollars.... | ..... | 109,586,595 |
| Loan and trust companies | Dollars.... | ..... | ..... |
| Private banks [10] | Dollars.... | ..... | ..... |
| Total bank deposits | Dollars.... | ..... | ..... |
| Depositors in savings banks | Number... | ..... | 251,354 |
| GOVERNMENT RECEIPTS: | | | |
| Net ordinary [11] | Dollars.... | 10,848,749 | 43,592,889 |
| Customs | Dollars.... | 9,080,933 | 39,668,686 |
| Internal revenue | Dollars.... | 809,397 | ..... |
| GOVERNMENT EXPENDITURES: | | | |
| Net ordinary [12] | Dollars.... | 7,411,370 | 37,165,990 |
| War | Dollars.... | 2,560,879 | 9,687,025 |
| Navy | Dollars.... | 3,448,716 | 7,904,725 |
| Pensions | Dollars.... | 64,131 | 1,866,886 |

[1] Exclusive of Alaska and islands belonging to the United States.

[2] For other than census years the figures represent estimates of the actuary of the Treasury Department.

[3] True valuation of real and personal property.

[4] Estimated.

[5] 1800 to 1840, outstanding principal of the public debt January 1; 1850 to 1855, outstanding principal of the public debt July 1.

[6] Figures for the years 1800 to 1855 include the total public debt.

[7] Gold and silver cannot be stated separately prior to 1876. From 1862 to 1875, inclusive, gold and silver were not in circulation except on the Pacific coast, where it is estimated that the average specie circulation was about $25,000,000, and this estimate is continued for the three following years under the head of gold. After that period gold was available for circulation.

## IN ITS AREA, POPULATION, AND MATERIAL INDUSTRIES.

Issued by the Bureau of Statistics, Department of Commerce and Labor.

| 1860. | 1870. | 1880. | 1890. | 1900. | 1904. |
|---|---|---|---|---|---|
| 3,025,600 | 3,025,600 | 3,025,600 | 3,025,600 | 3,025,600 | 3,025,600 |
| 31,443,321 | 38,558,371 | 50,155,783 | 62,622,250 | 76,303,387 | 81,752,000 |
| 10.39 | 12.74 | 16.57 | 20.70 | 25.22 | 27.02 |
| 16,159,616,000 | 30,068,518,000 | 42,642,000,000 | 65,037,091,000 | [4] 94,300,000,000 | ..... |
| 513.93 | 779.83 | 850.20 | 1,038.57 | 1,235.86 | ..... |
| 59,964,402.01 | 2,331,169,956.21 | 1,919,326,747.75 | 890,784,370.53 | 1,107,711,257.89 | 967,231,773.75 |
| 1.91 | 60.46 | 38.27 | 14.22 | 14.52 | 11.83 |
| 64,640,838 | 2,046,455,722 | 1,723,993,100 | 725,313,110 | 1,023,478,860 | 895,157,440 |
| 3,443,687 | 118,784,960 | 79,633,981 | 29,417,603 | 33,545,130 | 24,176,745 |
| 0.11 | 3.08 | 1.59 | 0.47 | 0.44 | 0.30 |
| 23,473,654 | 23,198,788 | 62,308,279 | 20,467,183 | 99,272,943 | 233,402,428 |
| 2,259,390 | 1,378,256 | 27,411,694 | 39,202,908 | 36,345,321 | 15,695,610 |
| 15.29 | 15.57 | 18.05 | 19.75 | 33.33 | 35.70 |
| [8] 228,304,775 | 25,000,000 | 225,695,779 | 374,258,923 | 610,806,472 | 645,817,576 |
| ..... | ..... | 68,622,345 | 110,311,336 | 142,050,334 | 166,842,169 |
| ..... | ..... | 7,963,900 | 130,830,859 | 200,733,019 | 465,655,099 |
| ..... | ..... | 5,789,569 | 297,556,238 | 408,465,574 | 461,138,698 |
| ..... | 324,962,638 | 327,895,457 | 334,688,977 | 313,971,545 | 333,759,425 |
| ..... | 288,648,081 | 337,415,178 | 181,604,937 | 300,115,112 | 433,027,836 |
| 207,102,477 | 36,602,075 | ..... | ..... | 79,008,942 | 12,902,057 |
| 435,407,252 | 675,212,794 | 973,382,228 | 1,429,251,270 | 2,055,150,998 | 2,519,142,860 |
| 13.85 | 17.50 | 19.41 | 22.82 | 26.94 | 30.77 |
| ..... | 1,612 | 2,076 | 3,484 | 3,732 | 5,331 |
| ..... | 427,235,701 | 455,909,565 | 642,073,676 | 621,536,461 | 767,378,148 |
| ..... | 719,341,186 | 994,712,646 | 1,933,509,333 | 2,623,512,201 | 3,595,013,467 |
| 7,231,143,057 | 27,804,539,406 | 37,182,128,621 | 37,660,686,572 | 51,964,588,564 | 59,672,796,804 |
| ..... | ..... | ..... | 58,845,279,505 | 84,582,450,081 | 102,150,313,982 |
| ..... | 542,261,563 | 833,701,034 | 1,521,745,665 | 2,458,092,758 | 3,312,439,842 |
| 149,277,504 | 549,874,358 | 819,106,973 | 1,524,844,506 | 2,449,547,885 | 2,918,775,329 |
| 257,229,562 | ..... | 208,751,611 | 553,054,584 | 1,266,735,282 | 2,073,218,049 |
| ..... | ..... | 90,008,008 | 336,456,592 | 1,028,232,407 | 1,600,322,325 |
| ..... | ..... | 182,667,235 | 99,521,667 | 96,206,049 | 95,791,454 |
| ..... | ..... | 2,134,234,861 | 4,035,622,914 | 7,298,814,381 | 10,000,546,999 |
| 693,870 | 1,630,846 | 2,335,582 | 4,258,893 | 6,107,083 | 7,305,443 |
| 56,054,600 | 395,959,834 | 333,526,501 | 403,080,983 | 567,240,852 | 540,631,749 |
| 53,187,512 | 194,538,374 | 186,522,065 | 229,668,585 | 233,164,871 | 261,274,565 |
| ..... | 184,899,756 | 124,009,374 | 142,606,706 | 295,327,927 | 232,904,119 |
| 60,056,755 | 164,421,507 | 119,090,062 | 261,637,203 | 447,553,458 | [13] 557,755,832 |
| 16,472,203 | 57,655,675 | 38,116,916 | 44,582,838 | 134,774,768 | 115,035,411 |
| 11,514,650 | 21,780,230 | 13,536,985 | 22,006,206 | 55,953,078 | 102,956,102 |
| 1,100,802 | 28,340,202 | 56,777,174 | 106,936,855 | 140,877,316 | 142,559,266 |

[8] Total specie in circulation; gold and silver were not separately stated prior to 1876.
[9] Includes notes of bank of United States, State bank notes, demand notes of 1862 and 1863; fractional currency 1863 to 1878; Treasury notes of 1890, 1891 to date, and currency certificates, act of June 8, 1872, 1892 to 1900.
[10] Includes all private banks from 1875 to 1882; from 1887 to date includes only those voluntarily reporting, estimated at one-fourth of total private banks.
[11] "Net ordinary receipts" include receipts from customs, internal revenue, direct tax, public lands, and "miscellaneous," but do not include receipts from loans, premiums, or Treasury notes, or revenues of Post-office Department.
[12] "Net ordinary expenses" include expenditures for war, Navy, Indians, pensions, and "miscellaneous," but do not include payments for interest, premiums, or principal of public debt, or expenditures for postal service.
[13] Includes $50,164,500 paid on account of Panama Canal.

SUMMARY OF PROGRESS OF THE UNITED STATES IN ITS

| Area, Population, and Industries. | In | 1800. | 1850. |
|---|---|---|---|
| Government Expenditures—Continued. | | | |
| Interest on public debt | Dollars | 3,402,601 | 3,782,393 |
| Pensioners | Number | | |
| IMPORTS OF MERCHANDISE: | | | |
| Total | Dollars | 91,252,768 | 173,509,526 |
| Per capita [1] | Dollars | 17.19 | 7.48 |
| EXPORTS OF MERCHANDISE: | | | |
| Total | Dollars | 70,971,780 | 144,375,726 |
| Per capita [2] | Dollars | 13.37 | 6.23 |
| IMPORTS OF GOLD AND SILVER: | | | |
| Gold | Dollars | | 1,776,706 |
| Silver | Dollars | | 2,852,086 |
| EXPORTS OF GOLD AND SILVER: | | | |
| Gold [3] | Dollars | | 4,560,627 |
| Silver [3] | Dollars | | 2,962,367 |
| IMPORTS FOR CONSUMPTION, GROUPED ACCORDING TO DEGREE OF MANUFACTURE AND USES: | | | |
| Food and live animals | Dollars | | 32,718,076 |
| Per cent of total | | | 18.86 |
| Crude articles for domestic industries | Dollars | | 18,105,147 |
| Per cent of total | | | 10.44 |
| Articles manufactured wholly or partially for use as materials in the mechanic arts | Dollars | | 30,857,522 |
| Per cent of total | | | 17.78 |
| Articles manufactured ready for consumption | Dollars | | 65,887,552 |
| Per cent of total | | | 37.97 |
| Articles of voluntary use, luxuries, etc | Dollars | | 25,941,229 |
| Per cent of total | | | 14.95 |
| Total imports | Dollars | | 173,509,528 |
| DOMESTIC MERCHANDISE EXPORTED, GROUPED ACCORDING TO SOURCES OF PRODUCTION: | | | |
| Agricultural products | Dollars | 25,590,534 | 108,605,713 |
| Per cent of total | | 80.37 | 80.51 |
| Manufactures | Dollars | 2,493,755 | 17,580,456 |
| Per cent of total | | 7.83 | 13.03 |
| Mining | Dollars | | 167,090 |
| Per cent of total | | | 0.12 |
| Forest | Dollars | 2,228,863 | 4,590,747 |
| Per cent of total | | 7.00 | 3.40 |
| Fisheries | Dollars | 1,098,511 | 2,824,818 |
| Per cent of total | | 3.45 | 2.10 |
| Miscellaneous | Dollars | 429,240 | 1,131,409 |
| Per cent of total | | 1.35 | 0.84 |
| Total domestic exports | Dollars | 31,840,903 | 134,900,233 |
| IMPORTS BY GRAND DIVISIONS OF THE WORLD: [4] | | | |
| Europe | Dollars | 46,857,960 | 124,954,302 |
| Per cent of total | | 51.35 | 70.14 |
| North America | Dollars | 32,116,092 | 24,136,879 |
| Per cent of total | | 35.19 | 13.55 |
| South America | Dollars | | 16,647,637 |
| Per cent of total | | | 9.35 |
| Asia | Dollars | 11,560,810 | 10,315,486 |
| Per cent of total | | 12.67 | 5.79 |
| Oceania [5] | Dollars | 142,969 | 1,401,340 |
| Per cent of total | | 0.16 | 0.79 |
| Africa | Dollars | 551,496 | 682,151 |
| Per cent of total | | 0.60 | 0.38 |
| EXPORTS BY GRAND DIVISIONS OF THE WORLD: [4] | | | |
| Europe | Dollars | 41,348,088 | 113,862,253 |
| Per cent of total | | 58.26 | 74.96 |
| North America | Dollars | 27,208,618 | 24,722,610 |
| Per cent of total | | 38.34 | 16.27 |

[1] Based on total imports to 1860; after that on imports for consumption only.
[2] Based on total exports to 1860; after that on domestic exports only.
[3] Gold and silver cannot be separately stated in domestic exports before 1864, but it is probable that the greater portion of the exports was gold. Gold and silver contained in ore are included under gold and silver since 1894.

AREA, POPULATION, AND MATERIAL INDUSTRIES—Continued.

| 1860. | 1870. | 1880. | 1890. | 1900. | 1904.[8] |
|---|---|---|---|---|---|
| 3,144,121 | 129,235,498 | 95,757,575 | 36,099,284 | 40,160,333 | 24,646,490 |
| 8,636 | 198,686 | 250,802 | 537,944 | 993,529 | 994,762 |
| 353,616,119 | 435,958,408 | 667,954,746 | 789,310,409 | 849,941,184 | 991,087,371 |
| 11.25 | 11.06 | 12.51 | 12.35 | 10.88 | 12.12 |
| 333,576,057 | 392,771,768 | 835,638,658 | 857,828,684 | 1,394,483,082 | 1,460,827,271 |
| 10.61 | 9.77 | 16.43 | 13.50 | 17.96 | 17.87 |
| 2,508,786 | 12,056,950 | 80,758,396 | 12,943,342 | 44,573,184 | 99,055,368 |
| 6,041,349 | 14,362,229 | 12,275,914 | 21,032,984 | 35,256,302 | 27,768,814 |
| 58,446,039 | 33,635,962 | 3,639,025 | 17,274,491 | 48,266,759 | 81,459,986 |
| 8,100,200 | 24,519,704 | 13,503,894 | 34,873,929 | 56,712,275 | 49,472,702 |
| 78,338,514 | 139,213,092 | 199,165,963 | 288,600,646 | 216,107,303 | 237,033,343 |
| 22.15 | 32.65 | 31.72 | 32.13 | 26.02 | 24.14 |
| 61,570,477 | 66,909,565 | 160,055,876 | 178,435,512 | 299,351,033 | 306,524,755 |
| 17.41 | 15.69 | 25.52 | 23.06 | 36.04 | 31.23 |
| 31,939,551 | 53,658,296 | 73,186,963 | 84,700,568 | 80,575,042 | 137,378,127 |
| 9.03 | 12.59 | 11.66 | 10.94 | 9.70 | 13.99 |
| 123,741,654 | 119,298,235 | 130,004,643 | 154,469,354 | 130,577,155 | 168,587,245 |
| 35.00 | 27.98 | 20.72 | 19.96 | 15.72 | 17.17 |
| 58,025,923 | 47,266,822 | 65,141,826 | 107,468,732 | 103,908,719 | 132,299,080 |
| 16.41 | 11.09 | 10.38 | 13.91 | 12.51 | 13.47 |
| 353,616,119 | 426,346,010 | 627,555,271 | 773,674,812 | 830,519,252 | 981,822,559 |
| 256,560,972 | 361,188,483 | 685,961,091 | 629,820,808 | 835,858,123 | 853,643,073 |
| 81.13 | 79.35 | 83.25 | 74.51 | 60.98 | 59.48 |
| 40,345,892 | 68,279,764 | 102,856,015 | 151,102,376 | 433,851,756 | 452,415,921 |
| 12.76 | 15.00 | 12.48 | 17.87 | 31.65 | 31.52 |
| 999,465 | 5,026,111 | 5,863,232 | 22,297,755 | 37,843,742 | 45,981,213 |
| 0.31 | 1.10 | 0.71 | 2.64 | 2.76 | 3.20 |
| 10,299,959 | 14,897,963 | 17,321,268 | 29,473,084 | 52,218,112 | 68,906,956 |
| 3.26 | 3.27 | 2.11 | 3.49 | 3.81 | 4.80 |
| 4,156,480 | 2,835,508 | 5,255,402 | 7,458,385 | 6,326,620 | 8,543,676 |
| 1.31 | 0.62 | 0.64 | 0.88 | 0.46 | 0.60 |
| 3,879,655 | 2,980,512 | 6,689,345 | 5,141,420 | 4,665,218 | 5,688,178 |
| 1.23 | 0.66 | 0.81 | 0.61 | 0.34 | 0.40 |
| 316,242,423 | 455,208,341 | 823,946,353 | 845,293,828 | 1,370,763,571 | 1,435,179,017 |
| 216,831,353 | 249,540,283 | 370,821,782 | 449,987,266 | 440,567,314 | 498,697,379 |
| 59.87 | 53.98 | 55.52 | 57.14 | 51.84 | 50.32 |
| 75,082,583 | 126,544,611 | 130,077,225 | 148,368,706 | 130,035,221 | 198,778,952 |
| 20.73 | 27.42 | 19.47 | 18.84 | 15.30 | 20.06 |
| 35,992,719 | 43,596,045 | 82,126,922 | 90,006,144 | 93,666,774 | 120,364,113 |
| 9.94 | 9.41 | 12.30 | 11.43 | 11.02 | 12.14 |
| 26,201,603 | 31,413,378 | 67,008,793 | 67,506,833 | 139,842,330 | 143,509,153 |
| 7.24 | 6.78 | 10.02 | 8.57 | 16.45 | 14.48 |
| 3,495,226 | 1,423,212 | [6] 14,130,604 | 28,356,568 | 34,611,108 | 20,310,998 |
| 0.96 | 0.31 | 2.13 | 3.60 | 4.07 | 2.05 |
| 3,798,518 | [7] 9,860,058 | 3,789,420 | 3,321,477 | 11,218,437 | 9,426,776 |
| 1.05 | 2.10 | 0.56 | 0.42 | 1.32 | 0.95 |
| 310,272,818 | 420,184,014 | 719,433,788 | 683,736,397 | 1,040,167,763 | 1,057,930,131 |
| 77.54 | 79.35 | 86.10 | 79.74 | 74.60 | 72.42 |
| 53,325,937 | 68,962,006 | 69,437,783 | 94,100,410 | 187,594,625 | 234,909,959 |
| 13.33 | 13.03 | 8.31 | 10.98 | 13.45 | 16.08 |

[4] In 1870 specie is included in totals, but excluded in following years.
[5] Hawaiian Islands not included since 1900.
[6] Includes "All other Spanish possessions."
[7] Includes "All other countries."
[8] Data for 1904 are based on general imports.

SUMMARY OF PROGRESS OF THE UNITED STATES IN ITS

| Area, Population, and Industries. | In | 1800. | 1850. |
|---|---|---|---|
| Exports by Grand Divisions of the World—Cont'd. | | | |
| South America | Dollars | | 9,076,724 |
| Per cent of total | | | 5.98 |
| Asia | Dollars | 1,177,846 | 3,051,720 |
| Per cent of total | | 1.66 | 2.01 |
| Oceania [1] | Dollars | 14,112 | 208,129 |
| Per cent of total | | 0.02 | 0.14 |
| Africa | Dollars | 1,110,374 | 977,284 |
| Per cent of total | | 1.56 | 0.64 |
| TRANSPORTATION OF FOREIGN COMMERCE: | | | |
| Imports— | | | |
| By sea { In American vessels | Dollars | | 139,657,043 |
| By sea { In foreign vessels | Dollars | | 38,481,275 |
| Total | Dollars | | 178,138,318 |
| Share carried in American vessels | Per cent. | | 78.4 |
| By land vehicles | Dollars | | |
| Total by land and sea | Dollars | | 178,138,318 |
| Exports— | | | |
| By sea { In American vessels | Dollars | | 99,615,041 |
| By sea { In foreign vessels | Dollars | | 52,283,679 |
| Total | Dollars | | 151,998,720 |
| Share carried in American vessels | Per cent. | | 65.4 |
| By land vehicles | Dollars | | |
| Total by land and sea | Dollars | | 151,998,720 |
| FOREIGN COMMERCE OF PRINCIPAL CUSTOMS DISTRICTS: | | | |
| Boston { Imports | Dollars | | |
| Boston { Exports | Dollars | | |
| New York { Imports | Dollars | | |
| New York { Exports | Dollars | | |
| Philadelphia { Imports | Dollars | | |
| Philadelphia { Exports | Dollars | | |
| Baltimore { Imports | Dollars | | |
| Baltimore { Exports | Dollars | | |
| New Orleans { Imports | Dollars | | |
| New Orleans { Exports | Dollars | | |
| San Francisco { Imports | Dollars | | |
| San Francisco { Exports | Dollars | | |
| FARM STATISTICS: | | | |
| Farms | Number. | | 1,449,073 |
| Persons engaged in agriculture | Number. | | |
| Value of farms and farm property | Dollars | | 3,967,343,580 |
| Value of farm products | Dollars | | |
| FARM ANIMALS: | | | |
| Total value | Dollars | | 544,180,516 |
| Cattle | Number. | | 17,778,907 |
| Horses | Number. | | 4,336,719 |
| Sheep | Number. | | 21,773,220 |
| Mules | Number. | | 559,331 |
| Swine | Number. | | 30,354,213 |
| PRODUCTION OF PRINCIPAL COMMODITIES: | | | |
| Wool | Pounds. | | 52,516,959 |
| Wheat | Bushels. | | 100,485,944 |
| Corn | Bushels. | | 592,071,104 |
| Cotton | Bales. | 155,556 | 2,333,718 |
| Cane-sugar | Tons | | 110,526 |
| PRODUCTION OF PRINCIPAL MINERALS: | | | |
| Precious metals— | | | |
| Gold | Dollars | | 50,000,000 |
| Silver | Dollars | | 50,000 |
| Coal [7] | Tons | | 3,358,899 |
| Petroleum | Gallons. | | |
| Pig-iron | Tons | | 563,755 |

[1] Hawaiian Islands not included since 1900.
[2] Includes "All other Spanish possessions."
[3] Includes "All other countries."
[4] Gold values.
[5] Does not include value of products fed to live stock.

AREA, POPULATION, AND MATERIAL INDUSTRIES—Continued.

| 1860. | 1870. | 1880. | 1890. | 1900. | 1904. |
|---|---|---|---|---|---|
| 16,742,100 | 21,651,459 | 23,190,220 | 38,752,648 | 38,945,763 | 50,755,027 |
| 4.18 | 4.09 | 2.77 | 4.52 | 2.79 | 3.47 |
| 11,067,921 | 10,972,064 | 11,645,703 | 19,696,820 | 64,913,807 | [6] 151,347 |
| 2.77 | 2.07 | 1.39 | 2.30 | 4.66 | 4.12 |
| 5,373,497 | 4,334,991 | [2] 6,846,698 | 16,460,269 | 43,391,275 | 32,850,681 |
| 1.34 | 0.82 | 0.82 | 1.92 | 3.11 | 2.25 |
| 3,227,760 | [3] 3,414,768 | [2] 5,084,466 | 4,613,702 | 19,469,849 | 24,230,126 |
| 0.84 | 0.64 | 0.61 | 0.54 | 1.79 | 1.66 |
| 228,164,855 | 153,237,077 | 149,317,368 | 124,948,948 | 104,304,940 | 132,253,065 |
| 134,001,399 | 309,140,510 | 503,494,913 | 623,740,100 | 701,223,735 | 790,595,186 |
| 362,166,254 | 462,377,587 | 652,812,281 | 748,689,048 | 805,528,675 | 922,848,251 |
| 63.0 | 33.1 | 22.9 | 16.7 | 12.9 | 14.3 |
| ..... | ..... | 15,142,465 | 40,621,361 | 44,412,509 | 68,239,120 |
| 362,166,254 | 462,377,587 | 667,954,746 | 789,310,409 | 849,941,184 | 991,087,371 |
| 279,082,902 | 199,732,324 | 109,029,209 | 77,502,138 | 90,779,252 | 97,482,054 |
| 121,039,394 | 329,786,978 | 720,770,521 | 747,376,644 | 1,193,220,689 | 1,210,608,328 |
| 400,122,296 | 529,519,302 | 829,799,730 | 824,878,782 | 1,283,999,941 | 1,308,090,382 |
| 70.0 | 37.7 | 13.1 | 9.4 | 7.1 | 7.5 |
| ..... | ..... | 5,838,928 | 32,949,902 | 110,483,141 | 152,736,889 |
| 400,122,296 | 529,519,302 | 835,638,658 | 857,828,684 | 1,394,483,082 | 1,460,827,271 |
| 39,333,684 | 47,484,060 | 68,503,136 | 62,876,666 | 72,195,939 | 80,657,697 |
| 12,747,945 | 14,126,429 | 59,238,241 | 71,201,944 | 112,195,555 | 89,845,772 |
| 231,310,086 | 281,048,813 | 459,937,153 | 516,426,693 | 537,237,282 | 600,171,033 |
| 80,047,978 | 196,614,746 | 392,560,090 | 349,051,791 | 518,834,471 | 506,808,013 |
| 14,611,934 | 14,483,211 | 35,944,500 | 53,936,315 | 51,866,002 | 53,890,106 |
| 5,526,967 | 16,927,610 | 49,649,693 | 37,410,683 | 78,406,031 | 71,411,934 |
| 9,781,205 | 19,512,468 | 19,945,989 | 13,140,203 | 19,045,279 | 20,345,788 |
| 8,940,100 | 14,510,733 | 76,253,566 | 73,983,693 | 115,530,378 | 82,836,164 |
| 20,036,316 | 14,377,471 | 10,611,353 | 14,658,163 | 17,490,811 | 34,036,516 |
| 103,164,812 | 107,586,952 | 90,442,019 | 108,126,891 | 115,858,764 | 148,595,103 |
| 7,367,016 | 15,982,549 | 35,221,751 | 48,751,223 | 47,869,628 | 37,542,978 |
| 4,868,090 | 13,991,781 | 32,358,929 | 36,876,091 | 40,368,288 | 32,547,181 |
| 2,044,077 | 2,659,985 | 4,008,907 | 4,564,641 | 5,739,657 | ..... |
| ..... | 5,922,471 | 7,713,875 | 8,565,926 | 10,438,219 | ..... |
| 7,980,493,060 | [4] 8,944,857,749 | 12,180,501,538 | 16,082,267,689 | 20,514,001,838 | ..... |
| ..... | [4] 1,958,030,927 | 2,212,540,927 | 2,460,107,454 | [5] 3,764,177,706 | ..... |
| 1,089,329,915 | 1,524,960,149 | 1,576,917,556 | 2,418,766,028 | 2,228,123,134 | 2,998,247,479 |
| 25,616,019 | 25,484,100 | 33,258,000 | 52,801,907 | 43,902,414 | 61,049,315 |
| 6,249,174 | 8,248,800 | 11,201,800 | 14,213,837 | 13,537,524 | 16,736,059 |
| 22,471,275 | 40,853,000 | 40,765,900 | 44,336,072 | 41,883,065 | 51,630,144 |
| 1,151,148 | 1,179,500 | 1,729,500 | 2,331,027 | 2,086,027 | 2,757,916 |
| 33,512,867 | 26,751,400 | 34,034,100 | 51,602,780 | 37,079,356 | 47,009,367 |
| 60,264,913 | 162,000,000 | 232,500,000 | 276,000,000 | 288,636,621 | 291,783,032 |
| 173,104,924 | 235,884,700 | 498,549,868 | 399,262,000 | 522,229,505 | 552,399,517 |
| 838,792,740 | 1,034,255,000 | 1,717,434,543 | 1,489,970,000 | 2,105,102,516 | 2,467,480,934 |
| 4,861,292 | 3,114,592 | 5,761,252 | 7,311,322 | 9,436,416 | 10,011,374 |
| 119,040 | 46,800 | 92,802 | 136,503 | 149,191 | 217,606 |
| 46,000,000 | 50,000,000 | 36,000,000 | 32,845,000 | 79,171,000 | [6] 84,551,300 |
| 150,000 | 16,000,000 | 39,200,000 | 70,485,714 | 74,533,495 | [6] 69,305,000 |
| 18,513,123 | 32,863,000 | 63,822,830 | 140,866,931 | 240,789,309 | ..... |
| [8] 21,000,000 | 220,951,290 | 1,104,617,166 | 1,924,552,224 | 2,661,233,568 | ..... |
| 821,223 | 1,665,179 | 3,835,191 | 9,202,703 | 13,789,242 | ..... |

[6] Preliminary estimate.

[7] Pennsylvania anthracite shipments only from 1820 to 1867; entire coal product from 1868 to 1902.

[8] In addition to this it is estimated that 10,000,000 barrels ran to waste in and prior to 1862 for want of a market

SUMMARY OF PROGRESS OF THE UNITED STATES IN ITS

| Area, Population, and Industries. | In | 1800. | 1850. |
|---|---|---|---|
| Production of Principal Minerals—Continued. | | | |
| Steel | Tons | | |
| Copper | Tons | | 650 |
| Total value all mineral production in U. S. | Dollars | | |
| MANUFACTURING INDUSTRIES OF THE U. S.: | | | |
| Manufacturing establishments [1] | Number. | | 123,025 |
| Average employees [1] | Number. | | 957,059 |
| Wages and salaries paid [1] | Dollars | | 236,755,464 |
| Value of products [1] | Dollars | | 1,019,106,616 |
| MANUFACTURES OF IRON AND STEEL: [1] | | | |
| Establishments | Number. | | |
| Wages and salaries paid | Dollars | | |
| Value of products | Dollars | | |
| Imports | Dollars | | 20,145,067 |
| Exports | Dollars | 52,144 | 1,953,702 |
| TIN PLATES: | | | |
| Imports | Pounds. | | |
| Production | Lbs., net | | |
| MANUFACTURES OF COTTON: [3] | | | |
| Establishments [1] | Number. | | 1,094 |
| Wages and salaries paid [1] | Dollars | | |
| Value of products [1] | Dollars | | 61,869,184 |
| Exports | Dollars | | 4,734,424 |
| Imports | Dollars | | 20,108,719 |
| COTTON MOVEMENT: | | | |
| Domestic cotton taken by United States mills | Bales | | 595,000 |
| Spindles in operation on September 1— | | | |
| In Northern States | Number | | |
| In Southern States | Number | | |
| Total, United States | Number | | |
| Exports of domestic cotton | Pounds. | | 635,381,607 |
| | Dollars | | 71,984,616 |
| Raw cotton imported | Pounds. | 4,239,987 | 269,114 |
| MANUFACTURES OF WOOL: [3] | | | |
| Establishments [1] | Number. | | 1,675 |
| Wages and salaries paid [1] | Dollars | | |
| Value of products [1] | Dollars | | 48,608,779 |
| Imports | Dollars | | 19,620,619 |
| Raw wool imported | Pounds. | | 18,695,294 |
| MANUFACTURES OF SILK: | | | |
| Establishments [1] | Number. | | 67 |
| Wages and salaries paid [1] | Dollars | | |
| Value of products [1] | Dollars | | 1,809,476 |
| Imports | Dollars | | 17,639,624 |
| Raw silk imported | Pounds. | | |
| Imports of crude rubber | Pounds. | | |
| SUGAR: | | | |
| Imports | Pounds. | | 218,430,764 |
| | Dollars | | 7,555,603 |
| Average cost per pound in foreign countries | Cents | | 3.46 |
| Wholesale prices of granulated, at New York | Cents | | |
| Total consumption | Tons | | 239,409 |
| Consumption per capita | Pounds. | | 23.1 |
| COFFEE: | | | |
| Imports | Pounds. | | 145,272,687 |
| | Dollars | | 11,234,835 |
| Average import price per pound at New York | Cents | | 7.6 |
| Consumption per capita [6] | Pounds. | | 5.60 |
| TEA: | | | |
| Imports | Pounds. | | 29,872,654 |
| | Dollars | | 4,719,232 |
| Average import price per pound at New York | Cents | | 14.1 |
| Consumption per capita [6] | Pounds. | | 1.22 |

[1] No official figures in other than census years.

[2] 1891, last six months.

[3] Does not include hosiery and knit goods.

AREA, POPULATION, AND MATERIAL INDUSTRIES—Continued.

| 1860. | 1870. | 1880. | 1890. | 1900. | 1904. |
|---|---|---|---|---|---|
| ..... | 68,750 | 1,247,335 | 4,277,071 | 10,188,329 | ..... |
| 7,200 | 12,600 | 27,000 | 115,966 | 270,588 | ..... |
| ..... | 218,598,994 | 369,319,000 | 619,648,925 | 1,063,678,053 | ..... |
| 140,433 | 252,148 | 253,852 | 355,415 | 512,734 | ..... |
| 1,311,246 | 2,053,996 | 2,732,595 | 4,712,622 | 5,719,137 | ..... |
| 378,878,966 | 775,584,343 | 947,953,785 | 2,283,216,529 | 2,735,430,848 | ..... |
| 1,885,861,676 | 4,232,325,442 | 5,369,579,191 | 9,372,437,283 | 13,039,279,566 | ..... |
| ..... | 808 | 1,005 | 719 | 725 | ..... |
| ..... | 40,544,981 | 55,476,785 | 95,736,192 | 134,739,004 | ..... |
| ..... | 207,208,696 | 296,557,685 | 478,687,519 | 835,753,034 | ..... |
| 26,158,235 | 40,273,682 | 71,266,699 | 41,679,591 | 20,478,728 | 27,028,312 |
| 5,870,114 | 13,483,163 | 14,716,524 | 25,542,208 | 121,913,548 | 111,948,586 |
| ..... | 150,932,768 | 379,902,880 | 680,060,925 | 147,963,804 | 126,909,360 |
| ..... | ..... | ..... | [2] 2,236,743 | 677,969,600 | ..... |
| 1,091 | 956 | 756 | 905 | 1,055 | ..... |
| 23,940,108 | 39,044,132 | 45,614,419 | 69,489,272 | 94,039,951 | ..... |
| 115,681,774 | 177,489,739 | 192,090,110 | 267,981,724 | 339,200,320 | ..... |
| 10,934,796 | 3,787,282 | 9,981,418 | 9,999,277 | 24,003,087 | 22,403,713 |
| 33,215,541 | 23,380,053 | 29,929,366 | 29,918,055 | 41,296,239 | 49,462,755 |
| 979,000 | 857,000 | 1,795,000 | 2,325,000 | 3,644,000 | 3,935,000 |
| ..... | ..... | ..... | 12,700,000 | 14,400,000 | 15,200,000 |
| ..... | ..... | ..... | 1,360,000 | 4,700,000 | 7,650,000 |
| ..... | ..... | ..... | 14,060,000 | 9,100,000 | 22,850,000 |
| 1,767,686,338 | 958,553,523 | 1,822,061,114 | 2,471,799,853 | 3,100,533,138 | 3,063,192,760 |
| 191,300,555 | 227,074,624 | 211,525,905 | 250,963,792 | 241,832,737 | 370,110,246 |
| 2,005,529 | 1,698,133 | 3,547,792 | 8,606,049 | 67,398,521 | 48,840,590 |
| 1,476 | 3,208 | 2,330 | 1,693 | 1,414 | ..... |
| 11,699,620 | 35,928,150 | 40,687,612 | 58,397,470 | 64,389,312 | ..... |
| 73,454,000 | 193,257,262 | 238,035,686 | 270,527,511 | 296,990,454 | ..... |
| 43,141,988 | 34,490,668 | 33,911,093 | 56,532,432 | 16,164,446 | 17,733,788 |
| [4] | 49,230,199 | 128,131,747 | 105,431,285 | 155,928,455 | 173,742,834 |
| 139 | 86 | 382 | 472 | 483 | ..... |
| 1,050,224 | 1,942,286 | 9,146,705 | 17,762,441 | 20,982,194 | ..... |
| 6,607,771 | 12,210,662 | 41,033,045 | 87,208,454 | 107,256,258 | ..... |
| 32,726,134 | 23,904,048 | 32,138,690 | 38,636,374 | 30,834,373 | 31,973,680 |
| ..... | 533,589 | 2,562,236 | 7,347,909 | 13,043,714 | 16,692,950 |
| ..... | 9,624,098 | 16,826,099 | 33,842,374 | 49,377,138 | 59,015,551 |
| 694,823,197 | 1,196,773,569 | 1,829,291,684 | 2,934,011,560 | 4,018,036,530 | [5] 3,700,623,613 |
| 31,078,970 | 56,923,745 | 80,087,720 | 96,094,522 | 100,250,974 | 71,915,753 |
| 4.38 | 4.95 | 4.18 | 3.28 | 2.49 | 1.94 |
| ..... | 13.51 | 9.80 | 6.27 | 5.32 | 4.77 |
| 428,785 | 607,834 | 956,784 | 1,476,377 | 2,219,847 | 2,767,162 |
| 30.5 | 35.3 | 42.9 | 52.8 | 65.2 | 75.3 |
| 202,144,733 | 235,256,574 | 446,850,727 | 499,159,120 | 787,991,911 | 995,043,284 |
| 21,633,797 | 24,234,879 | 60,360,769 | 78,267,432 | 52,467,943 | 69,551,799 |
| 10.8 | 10.3 | 13.5 | 16.0 | 6.7 | 7.0 |
| 5.79 | 6.00 | 8.78 | 7.83 | 9.81 | 11.75 |
| 31,696,657 | 47,408,481 | 72,162,936 | 83,886,829 | 84,845,107 | 112,905,541 |
| 8,915,327 | 13,863,273 | 19,782,631 | 12,317,493 | 10,553,110 | 13,229,310 |
| 28.3 | 29.4 | 27.4 | 15.0 | 12.4 | 16.1 |
| 0.84 | 1.10 | 1.39 | 1.33 | 1.09 | 1.34 |

[4] Quantity not stated.

[5] Does not include sugar from Hawaii and Porto Rico.

[6] Consumption per capita based on net imports.

SUMMARY OF PROGRESS OF THE UNITED STATES IN ITS

| Area, Population, and Industries | In | 1800. | 1850. |
|---|---|---|---|
| RAILWAYS: | | | |
| In operation | Miles. | | 9,021 |
| Passengers carried | Number. | | |
| Freight carried one mile | Tons. | | |
| Freight rates per ton per mile | Cents. | | |
| Passenger cars | Number. | | |
| Freight cars | Number. | | |
| AMERICAN VESSELS: | | | |
| Built | Tons | 106,261 | 279,255 |
| Engaged in foreign trade and whale fisheries | Tons | 669,921 | 1,585,711 |
| Engaged in coastwise trade and cod and mackerel fisheries | Tons | 301,919 | 1,949,743 |
| Engaged in commerce of Great Lakes | Tons | | 108,266 |
| Vessels passing through the Sault Ste. Marie Canal | Tonnage. | | |
| FREIGHT RATES ON WHEAT, CHICAGO TO NEW YORK: | | | |
| Lake and canal [1] | Cts. per bu. | | |
| Lake and rail | Cts. per bu. | | |
| All rail | Cts. per bu. | | |
| CONSUMPTION OF WINES AND LIQUORS: | | | |
| Wines— | | | |
| Consumption | Gallons. | | 6,315,871 |
| Consumption per capita | Gallons. | | 0.27 |
| Malt liquors— | | | |
| Consumption | Gallons. | | 36,563,009 |
| Consumption per capita | Gallons. | | 1.58 |
| Distilled spirits— | | | |
| Consumption | Gallons. | | 51,833,473 |
| Consumption per capita | Gallons. | | 2.23 |
| Total consumption of wines and liquors | Proof galls. | | 94,712,353 |
| Total consumption per capita | Proof galls. | | 4.08 |
| PRICES OF STAPLE COMMODITIES: | | | |
| Pig iron, No. 1, foundry, per ton [3] | Dollars | | 20.88 |
| Steel rails, standard sections, per ton [4] | Dollars | | |
| Middling cotton, per pound [5] | Cents. | | 12.34 |
| Standard sheetings, per yard [6] | Cents. | | 7.87 |
| Standard prints, per yard [6] | Cents. | | 10.62 |
| Washed Ohio fleece wool, July 1—[7] | | | |
| Fine | Cents. | | 45 |
| Medium | Cents. | | 37 |
| Coarse | Cents. | | 30 |
| COMMERCIAL FAILURES: | | | |
| Reported | Number. | | |
| Amount of liabilities | Dollars | | |
| POST-OFFICE STATISTICS: | | | |
| Post-offices | Number. | 903 | 18,417 |
| Receipts of Post-office Department | Dollars | 280,804 | 5,499,985 |
| Telegraph messages sent [8] | Number. | | |
| Newspapers and periodicals published | Number. | | 2,526 |
| PUBLIC SCHOOLS: | | | |
| Pupils enrolled | Number. | | |
| Average daily attendance | Number. | | |
| Salaries paid superintendents and teachers | Dollars | | |
| Total expenditures | Dollars | | |
| STUDENTS IN COLLEGES, UNIVERSITIES, AND SCHOOLS OF TECHNOLOGY: | | | |
| Men | Number. | | |
| Women | Number. | | |
| Total | Number. | | |
| Patents issued | Number. | | 993 |
| Immigrants arrived | Number. | | 310,004 |

[1] Including canal tolls under 1882, but not Buffalo transfer charges.
[2] For domestic consumption; local rates for exports only 9.08 cents in 1900.
[3] At Philadelphia.
[4] At mills in Pennsylvania.
[5] Net prices at New York.
[6] At New York.
[7] In Eastern markets.

AREA, POPULATION, AND MATERIAL INDUSTRIES—Continued.

| 1860. | 1870. | 1880. | 1890 | 1900. | 1904. |
|---|---|---|---|---|---|
| 30,626 | 52,922 | 93,262 | 166,703 | 194,334 | ..... |
| ..... | ..... | ..... | 520,439,082 | 584,695,935 | ..... |
| ..... | ..... | ..... | 79,192,985,125 | 141,162,109,413 | ..... |
| ..... | ..... | ..... | 93 | 75 | ..... |
| ..... | ..... | 12,788 | 21,664 | 26,786 | ..... |
| ..... | ..... | 544,185 | 1,099,205 | 1,350,258 | ..... |
| 214,797 | 276,953 | 157,409 | 294,122 | 393,790 | 378,542 |
| 2,546,237 | 1,516,800 | 1,352,810 | 946,695 | 826,694 | 898,768 |
| 2,807,631 | 2,729,707 | 2,715,224 | 3,477,802 | 4,338,145 | 5,392,767 |
| 467,774 | 684,704 | 605,102 | 1,063,063 | 1,565,587 | 2,019,208 |
| 403,657 | 690,826 | 1,734,890 | 8,454,435 | 22,315,834 | 24,364,138 |
| 24.83 | 17.11 | 12.27 | 5.85 | 4.42 | ..... |
| ..... | 22.0 | 15.7 | 8.5 | 5.05 | ..... |
| ..... | 33.3 | 19.9 | 14.31 | [2] 9.98 | ..... |
| 11,059,141 | 12,225,067 | 28,329,541 | 28,956,981 | 30,427,491 | 44,693,516 |
| 0.35 | 0.32 | 0.56 | 0.46 | 0.40 | 0.55 |
| 101,346,669 | 204,756,156 | 414,220,165 | 855,792,335 | 1,221,500,160 | 1,494,191,325 |
| 3.22 | 5.31 | 8.26 | 13.67 | 16.01 | 18.28 |
| 89,968,651 | 79,895,708 | 63,526,694 | 87,829,562 | 97,248,382 | 121,101,997 |
| 2.86 | 2.07 | 1.27 | 1.40 | 1.27 | 1.48 |
| 202,374,461 | 296,876,931 | 506,076,400 | 972,578,878 | 1,349,176,033 | 1,659,986,838 |
| 6.44 | 7.70 | 10.09 | 15.53 | 17.68 | 20.31 |
| 22.75 | 33.25 | 28.50 | 18.40 | 19.98 | 15.57 |
| ..... | 106.75 | 67.50 | 31.75 | 32.29 | 28.00 |
| 11.00 | 23.98 | 11.51 | 11.07 | 9.25 | 11.75 |
| 8.73 | 14.58 | 8.51 | 7.00 | 6.05 | 7.13 |
| 9.50 | 12.41 | 7.41 | 6.00 | 5.00 | 5.00 |
| 55 | 46 | 46 | 33 | 28½ | 32½ |
| 50 | 45 | 48 | 37 | 31½ | 32½ |
| 40 | 43 | 42 | 29 | 27½ | 30½ |
| 3,676 | 3,546 | 4,735 | 10,907 | 10,774 | 12,199 |
| 79,807,000 | 88,242,000 | 65,752,000 | 189,856,964 | 138,495,673 | 144,202,311 |
| 28,498 | 28,492 | 42,989 | 62,401 | 76,688 | 71,131 |
| 8,518,067 | 19,772,221 | 33,315,479 | 60,882,097 | 102,354,579 | 143,582,624 |
| ..... | 9,157,646 | 29,215,509 | 63,258,762 | 79,696,227 | ..... |
| 4,051 | [9] 5,871 | 9,723 | 16,948 | 20,806 | 22,168 |
| ..... | 6,871,522 | 6,867,505 | 12,722,581 | 15,503,110 | ..... |
| ..... | 4,077,347 | 6,144,143 | 8,153,635 | 10,632,772 | ..... |
| ..... | 37,832,566 | 55,942,972 | 91,836,484 | 137,687,746 | ..... |
| ..... | 63,396,666 | 78,094,687 | 140,506,715 | 214,964,618 | ..... |
| ..... | ..... | ..... | 44,926 | 72,159 | ..... |
| ..... | ..... | ..... | 10,761 | 26,764 | ..... |
| ..... | ..... | [10] 38,227 | 55,687 | 98,923 | ..... |
| 4,778 | 13,333 | 13,947 | 26,292 | 26,499 | ..... |
| [11] 150,237 | [12] 387,203 | 457,257 | 455,302 | 448,572 | 815,361 |

[8] Western Union to 1885; includes Postal Telegraph 1885 to date.
[9] Figures from 1870 to date; from Rowell's Newspaper Directory.
[10] Figures for the year 1880 are for the calendar year preceding the fiscal year, and include non-resident graduates; figures of later years are exclusive of non-resident graduate students.
[11] Calendar year.
[12] Years ending June 30 to date.

COMPARISON OF THE CHINESE EMPIRE WITH EASTERN UNITED STATES
—*Booklover's Magazine.*

# CHAPTER XI.

## The Departments of the Federal Government.

The following is a brief résumé of the work carried on by the Departments of the Government service, and in many cases the individual bureaus and divisions are noted. Information germane to the work of the bureaus, etc., is cheerfully given.

### THE DEPARTMENT OF JUSTICE.

The Attorney-General is the head of the Department of Justice and the chief law officer of the Government. He represents the United States in matters involving legal questions; he gives his advice and opinion, when they are required by the President or by the heads of the other Executive Departments, on questions of law arising in the administration of their respective Departments; he exercises a general superintendence and direction over United States attorneys and marshals in all judicial districts in the States and Territories; and he provides special counsel for the United States whenever required by any Department of the Government.

### THE DEPARTMENT OF STATE.

The Secretary of State is charged, under the direction of the President, with the duties appertaining to correspondence with the public ministers and the consuls of the United States, and with the representatives of foreign powers accredited to the United States; and to negotiations of whatever character relating to the foreign affairs of the United States. He is also the medium of correspondence between the President and the chief executives of the several States of the United States; he has the custody of the Great Seal of the United States, and countersigns and affixes such seal to all executive proclamations, to various commissions, and to warrants for the extradition of fugitives from justice. He is regarded as the first in rank among the members of the Cabinet.

The Secretary of State is also the custodian of the treaties made with foreign States, and of the laws of the United States. He grants and issues passports, and exequaturs to foreign consuls in the United States are issued through his office. He publishes the laws and resolutions of Congress, amendments to the Constitution, and proclamations declaring the admission of new States into the Union. He is also charged with certain annual reports to Congress relating to commercial information received from diplomatic and consular officers of the United States.

### THE DEPARTMENT OF THE TREASURY.

The Secretary of the Treasury is charged by law with the management of the national finances. He prepares plans for the improvement of the revenue and for the support of the public credit; superintends the collection of the revenue, and directs the forms of keeping and rendering public accounts and of making returns; grants warrants for all moneys drawn from the Treasury in pursuance of appropriations made by law, and for the payment of moneys into the Treasury; and annually submits to Congress estimates of the probable revenues and disbursements of the Government. He also controls the construction of public buildings; the coinage and printing of money; the administration of the Life-Saving, Revenue-Cutter, and the Public Health and Marine-Hospital branches of the public service, and furnishes generally such information as may be required by either branch of Congress on all matters pertaining to the foregoing.

## THE DEPARTMENT OF WAR.

The Secretary of War is head of the War Department, and performs such duties as are required of him by law or may be enjoined upon him by the President concerning the military service. He is charged by law with the supervision of all estimates of appropriations for the expenses of the Department, including the military establishment; of all purchases of army supplies; of all expenditures for the support, transportation, and maintenance of the Army, and of such expenditures of a civil nature as may be placed by Congress under his direction. He also has supervision of the United States Military Academy at West Point and of military education in the Army, of the Board of Ordnance and Fortification, of the various battlefield commissions, and of the publication of the official Records of the War of the Rebellion. He has charge of all matters relating to national defense and seacoast fortifications, army ordnance, river and harbor improvements, the prevention of obstruction to navigation, and the establishment of harbor lines, and all plans and locations of bridges authorized by Congress to be constructed over the navigable waters of the United States require his approval. He also has charge of the establishment or abandonment of military posts, and of all matters relating to leases, revocable licenses, and all other privileges upon lands under the control of the War Department.

### THE GENERAL STAFF.

The General Staff Corps was organized under the provisions of an act of Congress approved February 14, 1903. Its principal duties are to prepare plans for the national defense and for the mobilization of the military forces in time of war; to investigate and report upon all questions affecting the efficiency of the Army and its state of preparation for military operations; to render professional aid and assistance to the Secretary of War and to general officers and other superior commanders and to act as their agents in informing and co-ordinating the action of all the different officers who are subject to the supervision of the Chief of Staff, and to perform such other military duties not otherwise assigned by law as may be from time to time prescribed by the President. The Chief of Staff, under direction of the President, or of the Secretary of War under the direction of the President, has supervision of all troops of the line and of the Adjutant-General's, Inspector-General's, Judge-Advocate-General's, Quartermaster's, Subsistence, Medical, Pay, and Ordnance Departments, the Corps of Engineers and the Signal Corps, and performs such other military duties not otherwise assigned by law as may be assigned to him by the President. Duties formerly prescribed by statute for the Commanding General of the Army as a member of the Board of Ordnance and Fortification and of the Board of Commissioners of the Soldiers' Home are performed by the Chief of Staff or some other officer designated by the President.

### SOME OF THE MILITARY BUREAUS.

The chiefs of the military bureaus of the War Department are officers of the Regular Army of the United States and part of the military establishment, viz.:

The Adjutant-General's Department is the bureau of orders and records of the Army. Orders and instructions emanating from the War Department and all regulations are issued by the Secretary of War through the Chief of Staff, and are communicated to troops and individuals in the military service through the Adjutant-General. His office is the repository for the records of the War Department which relate to the personnel of the permanent military establishment and militia in the service of the United States, to the military history of every commissioned officer and soldier thereof, and to the movements and operation of troops. The records of all appointments, promotions, resignations, deaths, and other casualties in the Army, the preparation and distribution of commissions, and the compilation and issue of the Army Register and of information concerning examinations for appointment and promotions pertain to the Adjutant-General's Office. The Adjutant-General is charged, under the direction of the Secretary of War, with the management of the recruiting service, the communication of instructions to officers detailed to visit encampments of militia, and the digesting, arranging, and preserving of their reports; also

the preparation of the annual returns of the militia required by law to be submitted to Congress.

The Quartermaster-General, aided by his assistants, provides transportation for the Army; also clothing and equipage, horses, mules, and wagons, vessels, forage, stationery, and other miscellaneous quartermaster stores and property for the Army, and of clothing and equipage for the militia; constructs necessary buildings, wharves, roads, and bridges at military posts, and repairs the same; furnishes water, heating and lighting apparatus; pays guides, spies, and interpreters, and is in charge of national cemeteries.

The Chief of Engineers commands the Corps of Engineers, which is charged with all duties relating to construction and repair of fortifications, whether permanent or temporary; with all works of defense; with all military roads and bridges, and with such surveys as may be required for these objects, or the movement of armies in the field. It is also charged with the river and harbor improvements, with military and geographical explorations and surveys, with the survey of the lakes, and with any other engineering work specially assigned to the corps by acts of Congress or orders of the Secretary of War.

The Chief of Ordnance commands the Ordnance Department, the duties of which consist in providing, preserving, distributing, and accounting for every description of artillery, small arms, and all the munitions of war which may be required for the fortresses of the country, the armies in the field, and for the whole body of the militia of the Union. In these duties are comprised those of determining the general principles of construction and of prescribing in detail the models and forms of all military weapons employed in war. They comprise also the duty of prescribing the regulations for the proof and inspection of all these weapons, for maintaining uniformity and economy in their fabrication, for insuring their good quality, and for their preservation and distribution.

The Chief Signal Officer is charged with the supervision of all military signal duties, and of books, papers, and devices connected therewith, including telegraph and telephone apparatus and the necessary meteorological instruments for use on target ranges and other military uses; the construction, repair, and operation of military telegraph lines, and the duty of collecting and transmitting information for the Army by telegraph or otherwise, and all other duties usually pertaining to military signaling.

## THE DEPARTMENT OF AGRICULTURE.

The Secretary of Agriculture is charged with the supervision of all public business relating to the agricultural industry. He appoints all the officers and employees of the Department, with the exception of the Assistant Secretary and the Chief of the Weather Bureau, who are appointed by the President, and directs the management of all the bureaus, divisions, and offices embraced in the Department. He exercises advisory supervision over agricultural experiment stations deriving support from the National Treasury. He controls the import and export of cattle, including cattle-carrying vessels, and directs interstate quarantine when rendered necessary by contagious cattle diseases. His duties and powers include the preservation, distribution, and introduction of birds and animals, game birds and other wild birds and animals in the United States, and the protection of wild game animals and wild birds in the district of Alaska. He is charged generally with carrying out the chief purpose of the Department, which is "to acquire and diffuse among the people of the United States useful information on subjects connected with agriculture, in the most comprehensive sense of that word, and to procure, propagate, and distribute among the people new and valuable seeds and plants."

### THE WEATHER BUREAU.

The Chief of the Weather Bureau, under the direction of the Secretary of Agriculture, has charge of the forecasting of weather; the issue of storm warnings; the display of weather and flood signals for the benefit of agriculture, commerce, and navigation; the gauging and reporting of rivers; the maintenance and operation of seacoast telegraph lines, and the collection and transmission of marine intelligence for the benefit of commerce and navigation; the reporting of temperature

and rain-fall conditions for the cotton interests; the display of frost and cold-wave signals; the distribution of meteorological information in the interests of agriculture and commerce, and the taking of such meteorological observations as may be necessary to establish and record the climatic conditions of the United States or as are essential for the proper execution of the foregoing duties.

### THE BUREAU OF ANIMAL INDUSTRY.

The Bureau of Animal Industry makes investigations as to the existence of dangerous communicable diseases of live stock; superintends the measures for their extirpation, and makes original investigations as to the nature and prevention of such diseases. It inspects live stock and their products slaughtered for food consumption; has charge of the inspection of import and export animals, of the inspection of vessels for the transportation of export animals, and of the quarantine stations for imported neat cattle, other ruminants, and swine; generally supervises the interstate movement of animals and reports on the condition and means of improving the animal industries of the country. It makes special investigations in regard to dairy subjects, inspects and certifies dairy products for export, and supervises the manufacture and interstate commerce of renovated butter.

### BUREAU OF CHEMISTRY.

The Bureau of Chemistry makes investigations of fertilizers, and agricultural products, and such analyses as pertain in general to the interests of agriculture. It investigates the composition and adulteration of foods and the composition of field products in relation to their nutritive value and to the constituents which they derive from the soil, fertilizers, and the air. It inspects imported food products and excludes from entry those injurious to health. It inspects food products exported to foreign countries where physical and chemical tests are required for such products. It co-operates with the chemists of the agricultural experiment stations in all matters pertaining to the relations of chemistry to agricultural interests. It also co-operates with the other scientific divisions of the Department in all matters relating to chemistry, and conducts investigations of a chemical nature for other Departments of the Government at the request of their respective Secretaries.

### BUREAU OF STATISTICS.

The statistician collects information as to crop production and the numbers and status of farm animals, through a corps of county and township correspondents, traveling agents, and other agencies, and obtains similar information from foreign countries through special agents, assisted by consular, agricultural, and commercial authorities. He records, tabulates, and coordinates statistics of agricultural production, distribution, and consumption, the authorized data of governments, institutes, societies, boards of trade, and individual experts; and issues a monthly crop report for the information of producers and consumers.

### DIVISION OF FOREIGN MARKETS.

The division of foreign markets has for its object the extension of the agricultural export trade of the United States. It investigates the requirements of foreign markets, studies the conditions of demand and supply as disclosed by the records of production, importation, and exportation, inquires into the obstacles confronting trade extension, and disseminates through printed reports and otherwise the information collected.

### OFFICE OF EXPERIMENT STATIONS.

The Office of Experiment Stations represents the Department in its relations to the agricultural colleges and experiment stations, which are now in operation in all the States and Territories, and directly manages the experiment stations in Alaska, Hawaii, and Porto Rico. It seeks to promote the interests of agricultural education and investigation throughout the United States. It collects and disseminates general information regarding the colleges and stations, and publishes accounts of agricultural investigations at home and abroad. It also indicates lines of inquiry, aids in the conduct of co-operative experiments, reports upon the expenditures and work of the stations, and in general furnishes them with such advice and assistance as will best promote the purposes for which they were established. It is also charged with investigations on the nutritive value and economy of human

foods and on irrigation and agricultural engineering, which are largely conducted in co-operation with the colleges and stations.

### DIVISION OF ENTOMOLOGY.

The entomologist obtains and disseminates information regarding injurious insects; investigates insects sent him in order to give appropriate remedies; conducts investigations of this character in different parts of the country, and mounts and arranges specimens for illustrative and museum purposes.

### DIVISION OF BIOLOGICAL SURVEY.

The division of biological survey studies the geographic distribution of animals and plants, and maps the natural life zones of the country; it also investigates the economic relations of birds and mammals, recommends measures for the preservation of beneficial and the destruction of injurious species, and has been charged with carrying into effect the provisions of the Federal law for the importation and protection of birds, contained in the act of Congress of May 25, 1900.

### BUREAU OF FORESTRY.

The Bureau of Forestry gives practical assistance to farmers, lumbermen, and others in the conservative handling of forest lands; investigates methods and trees for planting in the treeless West, and gives practical assistance to tree planters; studies commercially valuable trees to determine their special uses in forestry; tests the strength and durability of construction timbers and railroad ties; investigates forest fires, grazing, and other forest problems; and makes plans for practical forestry in the national forest reserves at the request of the Secretary of the Interior.

### BUREAU OF PLANT INDUSTRY.

The Bureau of Plant Industry studies plant life in all its relations to agriculture. It includes vegetable pathological and physiological investigations, botanical investigations and experiments, pomological investigations, grass and forage plant investigations, experimental gardens and grounds, the Arlington experimental farm, Congressional seed distribution, seed and plant introduction, and tea-culture experiments.

### VEGETABLE PATHOLOGICAL AND PHYSIOLOGICAL INVESTIGATIONS.

These investigations have for their objects the study of diseases of agricultural crops and economic plants, nutrition of plants, rotation of crops, and the general application of the principles of pathology and physiology to agriculture, the problems of crop improvement, and the production of better varieties of agricultural plants and of crops resistant to disease by means of breeding and selection.

### BOTANICAL INVESTIGATIONS AND EXPERIMENTS.

This office investigates botanical problems, including the purity and value of seeds; methods of controlling the spread of weeds and preventing their introduction into this country; the injurious effects and antidotes in the case of poisonous plants; the native plant resources of the country, and other phases of economic botany.

### GRASS AND FORAGE PLANT INVESTIGATIONS.

This office studies the natural history, geographical distribution, and uses of grasses and forage plants, as well as their adaptation to special soils and climates; introduces promising foreign varieties, and investigates the methods of cultivation of native and foreign sorts.

### POMOLOGICAL INVESTIGATIONS.

This branch of the Bureau collects and distributes information in regard to the fruit interests of the United States; investigates the habits and peculiar qualities of fruits; their adaptability to various soils and climates, and conditions of culture. It studies the methods of harvesting, handling, and storing fruits, with a view to improving our own markets and extending them into foreign countries.

### EXPERIMENTAL GARDENS AND GROUNDS.

This branch is charged with the care and ornamentation of the parks surrounding the Department buildings; with the duties connected with the conservatories and gardens, and with the testing and propagating of economic plants. It carries on investigations for the purpose of determining the best methods of improving the

culture of plants under glass, and other lines of investigation connected with intensive horticulture.

CONGRESSIONAL SEED DISTRIBUTION.

This office is charged with the purchase and distribution of valuable seed. The seeds are distributed in allotments to Senators, Representatives, Delegates in Congress, and the agricultural experiment stations, and also by the Secretary of Agriculture, as provided for by the law.

SEED AND PLANT INTRODUCTION.

This work has for its object the securing from all parts of the world of seeds and plants of new and valuable agricultural crops adapted to different parts of the United States.

ARLINGTON EXPERIMENTAL FARM.

The experiment farm is designed ultimately to become an adjunct to all branches of the Department. It will carry on investigations in the testing of agricultural crops, fruits, and vegetables.

TEA CULTURE EXPERIMENTS.

This branch of the Bureau has for its object the study of tea with a view to producing it in this country. Experiments are conducted in tea culture, and methods of growing, curing, and handling the tea are being worked out. The work is carried on at Summerville, S. C., and at Pierce, Texas.

BUREAU OF SOILS.

The Bureau of Soils has for its object the investigation of soils in their relation to crops, the mapping of soils, the investigation, mapping, and reclamation of alkali lands, and investigations of the growth, curing, and fermentation of tobacco.

OFFICE OF PUBLIC-ROAD INQUIRIES.

The Office of Public-Road Inquiries collects information concerning the systems of road management throughout the United States, conducts and promotes investigations and experiments regarding the best methods of road making and road-making materials, and prepares publications on this subject.

DIVISION OF PUBLICATIONS.

The division of publications edits all publications of the Department, including Farmers' Bulletins and other agricultural reports ordered printed by the Congress, with the exception of those issued by the Weather Bureau. It supervises all printing, binding, and illustration work of the Department. It directs the distribution of publications with the exception of those turned over by law to the Superintendent of Documents for sale at the price fixed by him; issues, in the form of press notices, official information of interest to agriculturists, and distributes to agricultural and other periodicals and writers synopses of Department publications.

## THE POST-OFFICE DEPARTMENT.

The Postmaster-General has the direction and management of the Post-office Department. He appoints all officers and employees of the Department, except the four Assistant Postmasters-General, who are appointed by the President, by and with the advice and consent of the Senate; appoints all postmasters whose compensation does not exceed $1,000; makes postal treaties with foreign Governments, by and with the advice and consent of the President, awards and executes contracts, and directs the management of the domestic and foreign mail service.

## THE DEPARTMENT OF THE NAVY.

The Secretary of the Navy performs such duties as the President of the United States, who is Commander in Chief, may assign him, and has the general superintendence of construction, manning, armament, equipment, and employment of vessels of war.

BUREAU OF NAVIGATION.

The duties of the Bureau of Navigation comprise all that relates to the promulgation, record, and enforcement of the Secretary's orders to the fleets and to the officers of the Navy, except such orders as pertain to the Office of the Secretary; the education of officers and men, including the Naval Academy and technical schools for officers (except the War College and Torpedo School), the apprentice establishment, and schools for the technical education of enlisted men, and to the supervision

and control of the Naval Home, Philadelphia; the enlistment and discharge of all enlisted persons, including appointed petty officers for general and special service. It controls all rendezvous and receiving ships, and provides transportation for all enlisted persons and appointed petty officers; establishes the complement of the crews of all vessels in commission; keeps the records of service of all squadrons, ships, officers, and men, and prepares the annual Naval Register for publication; has under its direction the preparation, revision, and enforcement of all tactics, drill books, signal codes, cipher codes, and the uniform regulations.

BUREAU OF YARDS AND DOCKS.

The duties of the Bureau of Yards and Docks comprise all that relates to the planning, construction, and maintenance of all docks (including dry docks), wharves, slips, piers, quay walls, and buildings of all kinds, for whatever purpose needed, within the limits of the navy-yards, but not of hospitals and magazines outside of those limits, nor of buildings for which it does not estimate. It repairs and furnishes all buildings, stores and offices in the several navy-yards, and is charged with the purchase, sale, and transfer of all land and buildings connected with the navy-yards; has under its sole control the general administration of the navy-yards; provides and has sole control of all landings, derricks, shears, cranes, sewers, dredging, railway tracks, cars, and wheels, trucks, grading, paving, walks, shade trees, inclosure walls and fences, ditching, reservoirs, cisterns, fire engines, and apparatus, all watchmen, and all things necessary, including labor, for the cleaning of the yards and the protection of the public property.

BUREAU OF EQUIPMENT.

The duties of the Bureau of Equipment comprise all that relates to the equipment of all vessels with rigging, sails, anchors, yeomen's stores, furniture not provided by other bureaus, navigation stores and supplies of all kinds, including nautical and navigating instruments and books, stationery, and blank books for commanding and navigating officers ashore and afloat, binnacles, flags, signal lights, running lights, and standing lights on board vessels, including all electrical apparatus for lighting purposes and searchlights, logs, leads, lines, and glasses, log books, ships' libraries, illuminating oil for all purposes, except that used in the engineer department of steamers, and fuel for steamers, the ropewalks, and the shops for making anchors and cables, rigging, sails, galleys, and cooking utensils, the Naval Observatory, Nautical Almanac, compass offices, and pilotage. It has under its control the Hydrographic Office, the collection of foreign surveys, publication and supply charts, sailing directions, and nautical works, and the dissemination of nautical and hydrographic information to the Navy and mercantile marine.

BUREAU OF ORDNANCE.

The duties of the Bureau of Ordnance comprise all that relates to the torpedo station, naval proving grounds, and magazines on shore; to the manufacture of offensive and defensive arms and apparatus (including torpedoes), all ammunition and war explosives; procures all machinery, apparatus, equipment, material, and supplies required by or for use with the above; recommends the armament to be carried by vessels of the Navy; the material, kind, and quality of the armor; the interior dimensions of revolving turrets and their requirements as regards rotation. It fixes, within the carrying power of vessels as determined by the Bureau of Construction and Repair, the location and command of the armament, and distributes the thickness of the armor; inspects the installation of the permanent fixtures of the armament and its accessories on board ship, and the methods of storing, handling, and transporting ammunition and torpedoes; designs and constructs turret ammunition hoists; determines the requirements of all ammunition hoists, and the method of construction of armories and ammunition rooms on board ship, and in conjunction with the Bureau of Construction and Repair, determines upon their location and that of ammunition hoists. It installs the armament and its accessories which are not permanently attached to any portion of the structure of the hull, excepting turret guns, turret mounts, and ammunition hoists, etc.; has cognizance of all electrically operated ammunition hoists, rammers, and gun-elevating gear which are in turrets, of electric range finders, of electric training and elevating gear for gun mounts not in turrets, of electrically operated air

compressors for charging torpedoes, and of all battle-order and range transmitters and indicators; designs internal arrangements of buildings at navy-yards where ordnance work is performed; designs, erects, and maintains all shops and buildings constructed for its own purpose outside the limits of navy-yards. It is charged with the purchase, sale, and transfer of all land and buildings in connection therewith, except at navy-yards, and with the preservation of public property under its control. It determines upon and procures all the tools, stores, stationery, blank books, forms, material, means, and appliances of every kind required in its shops, including fuel and transportation. It superintends all work done under it, and estimates for and defrays from its own funds the cost necessary to carry out its duties as above defined.

### BUREAU OF CONSTRUCTION AND REPAIR.

The duties of the Bureau of Construction and Repair comprise the responsibility for the structural strength and stability of all ships built for the Navy; all that relates to designing, building, fitting, and repairing the hulls of ships, turrets, spars, capstans, windlasses, steering gear, and ventilating apparatus, and, after consultation with the Bureau of Ordnance, and according to the requirements thereof as determined by that Bureau, the designing, construction, and installation of independent ammunition hoists, and the installation of the permanent fixtures of all other ammunition hoists and their appurtenances; placing and securing armor after the material, quality, and distribution of thickness have been determined by the Bureau of Ordnance; placing and securing on board ship, to the satisfaction of the Bureau of Ordnance, the permanent fixtures of the armament and its accessories as manufactured and supplied by that Bureau; installing the turret guns, turret mounts, and ammunition hoists, and such other mounts as require simultaneous structural work in connection with installation or removal; care and preservation of ships in ordinary, and requisitioning for or manufacturing all the equipage and supplies for ships prescribed by the authorized allowance lists. The Bureau of Construction and Repair also, after conference with the Bureau of Ordnance, designs the arrangements for centering the turrets, the character of the roller paths and their supports, and furnishes the Bureau every opportunity to inspect the installation on board of all permanent fixtures of the armament and accessories supplied by said Bureau. It has cognizance of all electric turret-turning machinery and of all electrically operated ammunition hoists (except turret hoists), the same to conform to the requirements of the Bureau of Ordnance as to power, speed, and control. It also has cognizance of stationary electrically operated fans or blowers for hull ventilation, boat cranes, deck winches, capstans, steering engines and telemotors therefor, and hand pumps not in the engine or fire rooms, and of electric launches and other boats supplied with electric motive power. It has charge of the docking of ships, and also designs the slips and the various buildings and shops, so far as their internal arrangements are concerned, where its work is executed, and is charged with the operating and cleaning of dry docks.

### BUREAU OF STEAM ENGINEERING.

The duties of the Bureau of Steam Engineering comprise all that relates to the designing, building, fitting out, repairing, and engineering of the steam machinery used for the propulsion of naval vessels, and will also include steam pumps, steam heaters and connections, and the steam machinery necessary for actuating the apparatus by which turrets are turned.

### MARINE CORPS.

The Commandant of the Marine Corps is responsible to the Secretary of the Navy for the general efficiency and discipline of the corps; makes such distribution of officers and men for duty at the several shore stations as shall appear to him to be most advantageous for the interests of the service; furnishes guards for vessels of the Navy, according to the authorized scale of allowance; under the direction of the Secretary of the Navy, issues orders for the movement of officers and troops, and such other orders and instructions for their guidance as may be necessary; and has charge and exercises general supervision and control of the recruiting service of the corps, and of the necessary expenses thereof, including the establishment of recruiting offices.

## THE DEPARTMENT OF THE INTERIOR.

The Secretary of the Interior is charged with the supervision of public business relating to Patents for Inventions; Pensions and Bounty Lands; the Public Lands and Surveys; the Indians; Education; railroads; the Geological Survey; the Hot Springs Reservation, Arkansas; Yellowstone National Park, Wyoming, and the Yosemite, Sequoia, and General Grant parks, California; forest reservations; distribution of appropriations for agricultural and mechanical colleges in the States and Territories; the custody and distribution of certain public documents; and supervision of certain hospitals and eleemosynary institutions in the District of Columbia. He also exercises certain powers and duties in relation to the Territories of the United States.

### COMMISSIONER OF PATENTS.

The Commissioner of Patents is charged with the administration of the patent laws, and supervises all matters relating to the issue of letters patent for new and useful inventions, discoveries, and improvements thereon, and also the registration of trademarks, prints, and labels. He is by statute made the tribunal of last resort in the Patent Office, and has appellate jurisdiction in the trial of interference cases, of the patentability of inventions, and of registration of trade-marks. He is aided by an assistant Commissioner, chief clerk, three examiners in chief, an examiner of interferences, and thirty-nine principal examiners.

### COMMISSIONER OF PENSIONS.

The Commissioner of Pensions supervises the examination and adjudication of all claims arising under laws passed by Congress granting bounty land or pension on account of service in the Army or Navy during the Revolutionary War and all subsequent wars in which the United States has been engaged. He is aided by two Deputy Commissioners and the chief clerk of the Bureau, each of whom has supervision over business arising in divisions of the Bureau assigned, under order of the Commissioner, to his immediate charge.

### COMMISSIONER OF THE GENERAL LAND OFFICE.

The Commissioner of the General Land Office is charged with the survey, management, and sale of the public domain, and the issuing of titles therefor, whether derived from confirmations of grants made by former governments, by sales, donations, or grants for schools, railroads, military bounties, or public improvements. He is aided by an Assistant Commissioner and chief clerk.

### COMMISSIONER OF EDUCATION.

The duties of the Commissioner of Education are to collect such statistics and facts as shall show the condition and progress of education in the several States and Territories, and to diffuse such information respecting the organization and management of schools and school systems and methods of teaching as shall aid the people of the United States in the establishment and maintenance of efficient school systems, and otherwise promote the cause of education throughout the country.

### DIRECTOR OF THE GEOLOGICAL SURVEY.

The Director of the Geological Survey has charge of the classification of public lands and examination of the geological structure, mineral resources, and products of the national domain, and the survey of forest reserves, including the preparation of topographic and geologic maps; also the measurement of streams and determination of the water supply of the United States, including the investigation of underground waters and artesian wells; and also the reclamation of arid lands, including the engineering operations to be carried on by the use of the reclamation fund created by act of June 17, 1902, from proceeds of sales of public lands.

## THE BOARD ON GEOGRAPHIC NAMES.

That uniform usage in regard to geographic nomenclature and orthography shall obtain throughout the Executive Departments of the Government, and particularly upon maps and charts issued by the various Departments and Bureaus, this Board is constituted. To it shall be referred all unsettled questions concerning geographic names which arise in the Departments, and the decisions of the Board are to be accepted by the Departments as the standard authority in such matters.—Organized September 4, 1890.

## THE NATIONAL ACADEMY OF SCIENCES.

(Incorporated by Act of Congress March 3, 1863.)

Section 3 of the act of incorporation provides: "That the National Academy of Sciences shall hold an annual meeting at such place in the United States as may be designated, and the academy shall, whenever called upon by any department of the Government, investigate, examine, experiment, and report upon any subject of science or art, the actual expense of such investigations, examinations, experiments, and reports to be paid from appropriations which may be made for the purpose; but the academy shall receive no compensation whatever for any services to the Government of the United States."

In accordance with this provision, the academy—which includes about one hundred members—has made many investigations and reports, at the request of the legislative and executive branches of the Government. The annual reports are published by Congress as House and Senate documents. Two meetings are held each year. The annual meeting is held in April, at Washington; the other in November, at such place as may be determined by the council.

## THE CIVIL SERVICE COMMISSION.

The purpose of the civil-service act (approved January 16, 1883), as declared in its title, is "to regulate and improve the civil service of the United States." It provides for the appointment of three Commissioners, not more than two of whom shall be adherents of the same political party, and makes it the duty of the Commission to aid the President, as he may request, in preparing suitable rules for carrying the act into effect. The act requires that the rules shall provide, among other things, for open competitive examinations for testing the fitness of applicants for the public service, the filling of classified positions by selections from among those passing with highest grades, an apportionment of appointments in the Departments at Washington among the States and Territories, a period of probation before absolute appointment, and the prohibition of the use of official authority to coerce the political action of any person or body. The act also provides for investigations touching the enforcement of the rules promulgated, and forbids, under penalty of fine or imprisonment, or both, the solicitation by any person in the service of the United States of contributions to be used for political purposes from persons in such service, or the collection of such contributions by any person in a Government building.

### THE CLASSIFIED SERVICE.

It is estimated that in 1902 there were 235,854 positions in the executive civil service, of which 20,931 were in the executive offices at Washington and 214,923 were outside. About 120,000 positions are classified subject to competitive examination under the civil service rules. Persons merely employed as laborers or workmen and persons nominated for confirmation by the Senate are exempted from the requirements of classification. Within these limits certain classes of positions are excepted from examination, among them being employees at postoffices not having free delivery, Indians, attorneys, pension examining surgeons, deputy collectors of internal revenue, office deputy marshals, and a few employees whose duties are of an important confidential or fiduciary nature.

### EXAMINATIONS.

Examinations are held in every State and Territory twice a year. Full information respecting these examinations is to be found in a manual issued by the Commission in January and July of each year, for free distribution. The examinations range in scope from technical, professional, or scientific subjects to those based wholly upon the age, physical condition, experience, and character as a workman of the applicant, and in some cases do not require ability to read or write. To insure practical tests of fitness 654 different kinds of examinations were held during the year ended June 30, 1902, each of which involved different tests and more than half of which contained no educational tests, but consisted of certificates of employers or fellow workmen. During the fiscal year ended June 30, 1903, 86,787 persons were examined, 64,439 passed, and 26,343 were appointed.

### THE FILLING OF VACANCIES.

A vacancy is filled from among the three persons of the sex called for standing highest on the appropriate register, the order being determined by the relative rating, except that the names of persons preferred under section 1754, Revised Statutes, come before all others. Until the rating of all papers of an examination is completed the identity of no applicant is known. A vacancy may also be filled by promotion, reduction, transfer, or reinstatement.

### MILITARY PREFERENCE.

Persons discharged from the military or naval service by reason of disability resulting from wounds or sickness incurred in the line of duty and who receive a rating of at least 65 are certified first for appointment. All others are required to obtain a rating of 70 or more to become eligible. The rule barring reinstatement after a separation of one year does not apply to any person honorably discharged after service in the civil war or the war with Spain, or his widow, or an army nurse of either war.

### THE PHILIPPINE CIVIL SERVICE.

Appointments to the insular civil service of the Philippines are made under an act passed by the Philippine Commission and rules promulgated by the Governor of the islands. The municipal service of Manila is also classified and subject to the provisions of the act and rules, which are similar to the United States act and rules. The United States Commission, under an Executive order, assists the Philippine Board by conducting examinations in the United States for the Philippine service and in all other practicable ways. These examinations are held only for positions for which competent natives cannot be found, the natives being preferred for appointment.

The United States rules permit the transfer of classified employees who have served for three years from the Philippine service to the Federal service.

### THE CIVIL SERVICE IN PORTO RICO AND HAWAII.

The Federal positions in Porto Rico and Hawaii by act of Congress fall within the scope of the civil service act and are filled in the same ways as competitive positions in the United States. The competitive system does not extend to the insular and municipal positions of the islands.

### UNCLASSIFIED LABORERS.

Appointments of unclassified laborers in the Departments at Washington under Executive order are required to be made in accordance with regulations to be approved by the heads of the several Departments and the Civil Service Commission. Such regulations have been adopted by several of the Departments, and the positions of laborers are being filled by the appointment of those applicants who are rated highest in age, physical condition, and industry and adaptability. The system is outside the civil service act and rules.

## THE INTERSTATE COMMERCE COMMISSION.

This Commission, appointed under "An act to regulate commerce," approved February 4, 1887, has authority to inquire into the management of the business of all common carriers who are subject to the provisions of the act. These are all which are "engaged in the transportation of passengers or property wholly by railroad, or partly by railroad and partly by water when both are used, under a common control, management, or arrangement, for a continuous carriage or shipment, from one State or Territory of the United States or the District of Columbia to any other State or Territory of the United States or the District of Columbia, or from any place in the United States to an adjacent foreign country, or from any place in the United States through a foreign country to any other place in the United States, and also in the transportation in like manner of property shipped from any place in the United States to a foreign country and carried from such place to a port of transshipment, or shipped from a foreign country to any place in the United States and carried to such place from a port of entry either in the United States or an adjacent foreign country." It has jurisdiction to inquire into and report upon the reasonableness of rates on interstate traffic, to decide questions of unjust discrimination and of undue preference, to prescribe the publicity to be given to joint tariffs, and to in-

stitute and carry on proceedings for the enforcement of the provisions of the law. It has power to call for reports, to require the attendance of witnesses and the production of books and papers, to hear complaints of a violation of the act made against any such carrier, and to determine what reparation shall be made to a party wronged; to institute inquiries on its own motion or at the request of State railroad commissions, and to report thereon; and it is required to make an annual report, which shall be transmitted to Congress.

The act of March 2, 1893, known as the "Safety Appliance Act," provides that within specified periods railroad cars used in interstate commerce must be equipped with automatic couplers and standard height of drawbars for freight cars, and have grab irons or handholds on the ends and sides of each car.

A further provision of this act is that locomotive engines used in moving interstate traffic shall be fitted with a power driving wheel brake and appliances for operating the train brake system, and a sufficient number of cars in the train shall be equipped with power or train brakes. The act directs the Commission to lodge with the proper district attorneys information of such violations as may come to its knowledge. The Commission is authorized, from time to time, upon full hearing and for good cause, to extend the period within which any common carrier shall comply with the provisions of the statute. The act of March 2, 1903, amended this act so as to make its provisions apply to Territories and the District of Columbia, to all cases when couplers of whatever design are brought together, and to all locomotives, cars, and other equipment of any railroad engaged in interstate traffic, except logging cars and cars used upon street railways, and also to power or train brakes used in railway operation.

The act of March 3, 1901, "requiring common carriers engaged in interstate commerce to make reports of all accidents to the Interstate Commerce Commission," makes it the duty of such carrier monthly to report, under oath, all collisions and derailments of its trains and accidents to its passengers, and to its employees while on duty in its service, and to state the nature and causes thereof. The act prescribes that a fine shall be imposed against any such carrier failing to make the report so required.

## THE DEPARTMENT OF COMMERCE AND LABOR.

The Secretary of Commerce and Labor is charged with the work of promoting the commerce of the United States, and its mining, manufacturing, shipping, fishery, transportation, and labor interests. His duties also comprise the investigation of the organization and management of corporations (excepting railroads) engaged in interstate commerce; the gathering and publication of information regarding labor interests and labor controversies in this and other countries; the administration of the Light House Service, and the aid and protection to shipping thereby; the taking of the census, and the collection and publication of statistical information connected therewith; the making of coast and geodetic surveys; the collecting of statistics relating to foreign and domestic commerce; the inspection of steamboats, and the enforcement of laws relating thereto for the protection of life and property; the supervision of the fisheries as administered by the Federal Government; the supervision and control of the Alaskan fur seal, salmon, and other fisheries; the jurisdiction over merchant vessels, their registry, licensing, measurement, entry, clearance, transfers, movement of their cargoes and passengers, and laws relating thereto, and to seamen of the United States; the supervision of the immigration of aliens, and the enforcement of the laws relating thereto, and to the exclusion of Chinese; the custody, construction, maintenance, and application of standards of weights and measurements; and the gathering and supplying of information regarding industries and markets for the fostering of manufacturing. He has power to call upon other Departments for statistical data obtained by them.

It is his further duty to make such special investigations and furnish such information to the President or Congress as may be required by them on the foregoing subject-matters and to make annual reports to Congress upon the work of said Department.

### BUREAU OF LABOR.

The Bureau of Labor is charged with the duty of acquiring and diffus-

ing among the people of the United States useful information on subjects connected with labor in the most general and comprehensive sense of that word, and especially upon its relations to capital, the hours of labor, the earnings of laboring men and women, and the means of promoting their material, social, intellectual, and moral prosperity.

It is especially charged to investigate the causes of and facts relating to all controversies and disputes between employers and employees as they may occur, and which may happen to interfere with the welfare of the people of the several States.

### LIGHT-HOUSE BOARD.

The Light-House Board has charge, under the superintendence of the Secretary of Commerce and Labor, of all administrative duties relating to the construction and maintenance of light-houses, light vessels, light-house depots, beacons, fog signals, buoys, and their appendages, and has charge of all records and property appertaining to the Light-House Establishment.

### BUREAU OF THE CENSUS.

The Bureau of the Census is charged with the duty of taking the periodical censuses of the United States and of collecting such special statistics as are required by Congress, including the collection in 1905 of the statistics of manufacturing establishments conducted under the factory system, and the collection annually of statistics of births and deaths in registration areas, statistics of the cotton production of the country as returned by the ginners, and (by transfer from the Bureau of Labor) statistics of cities of 30,000 or more inhabitants. Under the proclamation of the President dated September 30, 1902, the Bureau is charged with the compilation and tabulation of the returns of the Philippine census, taken as of March 2, 1903, under the direction of the Philippine Commission.

### COAST AND GEODETIC SURVEY.

The Coast and Geodetic Survey is charged with the survey of the coasts of the United States and coasts under the jurisdiction thereof and the publication of charts covering said coasts. This includes base measure, triangulation, topography, and hydrography along said coasts; the survey of rivers to the head of tide-water or ship navigation; deep sea soundings, temperature, and current observations along said coasts and throughout the Gulf and Japan streams; magnetic observations and researches, and the publication of maps showing the variations of terrestrial magnetism; gravity research; determination of heights; the determination of geographic positions by astronomic observations for latitude, longitude, and azimuth, and by triangulation, to furnish reference points for State surveys. The results obtained are published in annual reports, with professional papers and discussions of results as appendices; charts upon various scales, including sailing charts, general charts of the coast, and harbor charts; tide tables issued annually, in advance; Coast Pilots, with sailing directions covering the navigable waters; Notices to Mariners, issued monthly and containing current information necessary for safe navigation; catalogues of charts and publications, and such other special publications as may be required to carry out the organic law governing the Survey.

### BUREAU OF STATISTICS.

The Bureau of Statistics collects and publishes the statistics of our foreign commerce, embracing tables showing the imports and exports, respectively, by countries and customs districts; the transit trade inward and outward by countries and by customs districts; imported commodities warehoused, withdrawn from, and remaining in warehouse; the imports of merchandise entered for consumption, showing quantity, value, rates of duty, and amounts of duty collected on each article or class of articles; the inward and outward movement of tonnage in our foreign trade and the countries whence entered and for which cleared, distinguishing the nationalities of the foreign vessels. The Bureau also collects and publishes information in regard to the leading commercial movements in our internal commerce, among which are the commerce of the Great Lakes; the commercial movements in our internal commerce, among which are the commerce of the Great Lakes; the commercial movements at interior centers, at Atlantic, Gulf, and Pacific seaports; shipments of coal and coke; ocean freight rates,

etc. The Bureau also publishes daily and monthly the reports received from United States consuls and special reports on various subjects supplied by consuls on special request; also, annually, the declared exports from foreign countries to the United States furnished by consuls, and the annual report laid before Congress entitled "Commercial Relations of the United States."

STEAMBOAT-INSPECTION SERVICE.

The Steamboat-Inspection Service is charged with the duty of inspecting steam vessels, the licensing of the officers of vessels, and the administration of the laws relating to such vessels and their officers for the protection of life and property.

The Supervising Inspector-General and the supervising inspectors constitute a board that meets annually at Washington, and establishes regulations for carrying out the provisions of the steamboat-inspection laws.

BUREAU OF FISHERIES.

The work of the Bureau of Fisheries comprises (1) the propagation of useful food fishes, including lobsters, oysters, and other shellfish, and their distribution to suitable waters; (2) the inquiry into the causes of decrease of food fishes in the lakes, rivers, and coast waters of the United States, the study of the waters of the coast and interior in the interest of fish-culture, and the investigation of the fishing grounds of the Atlantic, Gulf, and Pacific coasts, with the view of determining their food resources and the development of the commercial fisheries; (3) the collection and compilation of the statistics of the fisheries and the study of their methods and relations.

BUREAU OF NAVIGATION.

The Bureau of Navigation is charged with general superintendence of the commercial marine and merchant seamen of the United States, except so far as supervision is lodged with other officers of the Government. It is specially charged with the decision of all questions relating to the issue of registers, enrollments, and licenses of vessels and the filing of those documents, with the supervision of laws relating to the admeasurement, letters, and numbers of vessels, and with the final decision of questions concerning the collection and refund of tonnage taxes. It is empowered to change the names of vessels, prepares annually a list of vessels of the United States, and reports annually to the Secretary of Commerce and Labor the operations of the laws relative to navigation.

BUREAU OF IMMIGRATION.

The Bureau of Immigration is charged with the administration of the laws relating to immigration and of the Chinese exclusion laws. It supervises all expenditures under the appropriations for "Expenses of regulating immigration" and the "Enforcement of the Chinese exclusion act." It causes alleged violations of the immigration, Chinese exclusion, and alien contract-labor laws to be investigated, and when prosecution is deemed advisable submits evidence for that purpose to the proper United States district attorney.

BUREAU OF STANDARDS.

The functions of the Bureau of Standards are as follows: The custody of the standards; the comparison of the standards used in scientific investigations, engineering, manufacturing, commerce,, and educational institutions with the standards adopted or recognized by the Government; the construction, when necessary, of standards, their multiples and subdivisions; the testing and calibration of standard measuring apparatus; the solution of problems which arise in connection with standards; the determination of physical constants and properties of materials, when such data are of great importance to scientific or manufacturing interests and are not to be obtained of sufficient accuracy elsewhere. The Bureau is authorized to exercise its functions for the Government of the United States, for any State or municipal government within the United States, or for any scientific society, educational institution, firm, corporation, or individual within the United States engaged in manufacturing or other pursuits requiring the use of standards or standard measuring instruments. For all comparisons, calibrations, tests, or investigations, except those performed for the Government of the United States or State governments, a reasonable fee will be charged.

BUREAU OF CORPORATIONS.

The law under which the Bureau of Corporations was created is section 6 of the act of Congress establishing the Department of Commerce and Labor, approved February 14, 1903, reading as follows:

SEC. 6. That there shall be in the Department of Commerce and Labor a bureau to be called the Bureau of Corporations, and a Commissioner of Corporations who shall be the head of said bureau, to be appointed by the President, who shall receive a salary of five thousand dollars per annum. There shall also be in said bureau a deputy commissioner who shall receive a salary of three thousand five hundred dollars per annum, and who shall in the absence of the Commissioner act as, and perform the duties of, the Commissioner of Corporations, and who shall also perform such other duties as may be assigned to him by the Secretary of Commerce and Labor or by the said Commissioner. There shall also be in the said bureau a chief clerk and such special agents, clerks, and other employees as may be authorized by law.

The said Commissioner shall have power and authority to make, under the direction and control of the Secretary of Commerce and Labor, diligent investigation into the organization, conduct, and management of the business of any corporation, joint stock company or corporate combination engaged in commerce among the several States and with foreign nations excepting common carriers subject to "An Act to regulate commerce," approved February fourth, eighteen hundred and eighty-seven, and to gather such information and data as will enable the President of the United States to make recommendations to Congress for legislation for the regulation of such commerce, and to report such data to the President from time to time as he shall require; and the information so obtained or as much thereof as the President may direct shall be made public.

In order to accomplish the purposes declared in the foregoing part of this section, the said Commissioner shall have and exercise the same power and authority in respect to corporations, joint stock companies and combinations subject to the provisions hereof, as is conferred on the Interstate Commerce Commission in said "Act to regulate commerce" and the amendments thereto in respect to common carriers so far as the same may be applicable, including the right to subpœna and compel the attendance and testimony of witnesses and the production of documentary evidence and to administer oaths. All the requirements, obligations, liabilities, and immunities imposed or conferred by said "Act to regulate commerce" and by "An Act in relation to testimony before the Interstate Commerce Commission," and so forth, approved February eleventh, eighteen hundred and ninety-three, supplemental to said "Act to regulate commerce," shall also apply to all persons who may be subpœnaed to testify as witnesses or to produce documentary evidence in pursuance of the authority conferred by this section.

It shall also be the province and duty of said Bureau, under the direction of the Secretary of Commerce and Labor, to gather, compile, publish, and supply useful information concerning corporations doing business within the limits of the United States as shall engage in interstate commerce or in commerce between the United States and any foreign country, including corporations engaged in insurance, and to attend to such other duties as may be hereafter provided by law.

## THE INTERNATIONAL BUREAU OF THE AMERICAN REPUBLICS.

The International Bureau of the American Republics was established under the recommendation of the International American Conference in 1890 for the purpose of maintaining closer relations between the several Republics of the Western Hemisphere. It was reorganized by the International American Conference of 1901 and its scope widened by imposing many new and important duties. A prominent feature of the new arrangement was the foundation of the Columbus Memorial Library. The International Bureau corresponds, through the diplomatic representatives of the several Governments in Washington, with the executive departments of these governments, and is required to furnish such information as it possesses or can obtain to any of the Republics making requests. It is the custodian of the archives of the International American Conferences, and is

especially charged with the performance of duties imposed upon it by these conferences. The International Bureau is sustained by contributions from the American Republics in proportion to their population. It publishes a monthly bulletin containing the latest official information respecting the resources, commerce, and general features of the American Republics, as well as maps and geographical sketches of these countries, which publications are considered public documents and as such are carried free in the mails of all the Republics.—Congressional Directory.

## THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

Any person may become a member of the association upon recommendation in writing by two members or fellows, and election by the council, or by the special committee of the council resident in Washington and empowered to pass upon applications whenever received.

The admission fee for members is five dollars, payable in advance. The annual dues for members and fellows are three dollars, payable in advance. The fiscal year of the association begins January 1st, and members and fellows are entitled to all publications issued, and to the privileges of all meetings held during the year for which they have paid dues.

Fellows are elected by the council from such of the members as are professionally engaged in science. The election of fellows is by ballot and a majority vote of the members of the council at a designated meeting of the council. On the election of any member as a fellow, an additional fee of two dollars shall be paid.

Any member or fellow who shall pay the sum of fifty dollars to the association, at any one time, shall become a life member, and as such shall be exempt from all further assessments, and shall be entitled to the proceedings of the association. All money thus received shall be invested as a permanent fund, the income of which, during the life of the member, shall form a part of the general fund of the association; but, after his death, shall be used only to assist in original research, unless otherwise directed by unanimous vote of the council.

Any person paying to the association the sum of one thousand dollars shall be classed as a patron, and shall be entitled to all the privileges of a member and to all its publications.

# CHAPTER XII.

## POST OFFICE.

### POSTAL INFORMATION.

Revised by the New York Post Office.

There are four classes of mail matter:

First-Class Matter—All written matter, such as letters, postal cards, "post cards" and all matter in writing, whether pen-written or typewritten, and all matter sealed from inspection, constitutes "First-class Matter," and is mailable at two cents an ounce, or fraction thereof. Letters, etc., may be sent to Canada, Cuba, the "Canal Zone" at Panama, Guam, Tutuila (Samoa), Shanghai (China), Mexico, Porto Rico, Hawaii, and the Philippines. Postal cards are one cent each. Local or "drop" letters are two cents an ounce or fraction thereof, when mailed at letter carrier offices, or at offices where Rural Delivery Service has been established, addressed to patrons thereof who may be served by rural carriers, and one cent for each ounce or fraction thereof at offices where free delivery by carrier is not established or at rural-delivery offices when addressed to patrons who cannot be served by the carriers.

Note—There is no "drop" rate on third or fourth-class matter; the postage on which is uniform whether addressed for local delivery or transmission in the mails.

The following articles are included in first-class matter: Assessment notices, autograph albums, blank books, with written entries, bank checks, blank forms filled out in writing, receipts, visiting cards bearing written name, communications entirely in print with the exception of name of sender, diplomas, drawings or plans containing written words, letters or figures, envelopes bearing written addresses, imitations or reproductions of hand or typewritten matter not mailed at the postoffice in a minimum number of twenty perfectly identical copies to separate addresses, legal and other blanks, old letters sent singly or in bulk, all sealed matter, stenographic or shorthand notes, and unsealed written communications.

Second-Class Matter—This division includes newspapers and other periodicals, which are issued as often as four times a year. The rate of postage on second-class matter when sent by the publisher thereof and from the office of publication to subscribers or as sample copies, or when sent from a news agency to actual subscribers or to other news agents for sale, is one cent a pound or fraction thereof, except when deposited in a letter carrier office for delivery by letter carriers, or mailed free within the county of publication. Publishers to obtain this rate must have their periodicals entered at their local post-office.

Third-Class Matter—Embraces all printed matter generally. The rate of postage is one cent for each two ounces or fractional part thereof sent to a single address, to be fully prepaid by ordinary postage stamps affixed thereto. The following named articles are among those subject to third-class rate of postage: Almanacs, printed architectural designs, blueprints, books (printed), bulbs, calendars printed on paper, cards printed on paper, Christmas cards, catalogues, check and receipt books (blank), circulars, press clippings, school copy books, printed engravings, samples of grain, imitation of hand or typewritten matter when mailed at the postoffice window in a minimum number of twenty identical copies separately addressed, printed labels, legal blanks, lithographs, maps, music books, photographs, plants, printed tags, roots, seeds, sheet music.

Fourth-Class Matter — Embraces merchandise, samples, and in general all articles not included in the first,

second or third class. The rate of postage is one cent an ounce or fraction thereof sent to a single address, to be prepaid by ordinary stamps affixed. The following are among articles included in fourth-class matter: Albums, photograph and autograph (blank), artificial flowers, billheads, blank books, blotters, botanical specimens, celluloid calendars, blank cards, celluloid, dried fruit, dried plants, electrotypes, geological specimens, maps printed on cloth, merchandise samples, merchandise sealed, metals, napkins, oil paintings, samples of cloth, samples of flour, soap wrappers, stationery.

Prohibited Articles.—Many articles are excluded from the foreign mails, the regulations being different in the case of each country. Inquiries should be made of the postmaster. Many articles are also excluded from domestic mails when they are liable to destroy, efface, or injure the contents of the mail bags or the persons of those engaged in the postal service. When in doubt consult your postmaster.

Withdrawal of Letters from the Mail.—It is not generally known that a letter can be withdrawn from the mail. For good and sufficient reasons and satisfactory identification a postmaster may telegraph to a postmaster in another city, asking him to withdraw the letter, a description of which is telegraphed. Special care is then given in assorting letters, and when the letter is found it is returned to the postmaster of the city where it was mailed, who delivers it to the person mailing it on presentation of proper proof of ownership. All expenses must be borne by the person withdrawing a letter from the mail. A deposit of $5 must be left with the postmaster when the application is made. It is also possible to withdraw a for-



| Domestic. | Number of letters. | | Number of post cards. | Printed matter. | Commercial papers. |
|---|---|---|---|---|---|
| | Postage prepaid. 1 | Not prepaid. 2 | 3 | 4 | 5 |
| Argentine Republic | 159,385,020 | See Col. 1 | 3,588,504 | 152,515,894 | See Col. 4 |
| Australasia | 211,254,801 | See Col. 1 | 2,705,126 | 43,064,753 | 38,227,430 |
| Austria | 440,675,600 | 4,180 400 | 264,989,700 | 55 221,700 | ..... |
| Belgium | 101,644,321 | 427,856 | 59,804,004 | 257,568,220 | 1,797,198 |
| Bolivia | 787,467 | 4,226 | 24,170 | 340,629 | 10,900 |
| British India | 222,394,627 | 28,462,364 | 227,062,615 | 59,367,511 | See Col. 4 |
| Bulgaria | 3,739,812 | 186,854 | 6,042,720 | 8,955,534 | 90,304 |
| Chili | 24,768,283 | 448 609 | 462,694 | 948,864 | 4,964 |
| Costa Rica | 1,820,831 | ..... | 69,726 | 1,328,214 | 366,104 |
| Cuba | 6,489,631 | 18,296 | 1,916,326 | 902,500 | 1,050,300 |
| Denmark | 74,223,431 | 99,418 | 4,764,940 | 4,354,662 | ..... |
| Dominican Republic | 781,080 | 65,883 | 14,475 | 459,867 | ..... |
| Egypt | 12,060,000 | 300,000 | 590,000 | 9,400,000 | 80,000 |
| France | 820,708,041 | 3,016,145 | 64,442,350 | 1,130,475,202 | 43,811,675 |
| Germany | 1,557,679,710 | 30,259,540 | 1,062,679,460 | 957,361,710 | 8,460,270 |
| Great Britain | 2,579,500,000 | See Col. 1 | 488,900,000 | 175,400,000 | 809,800,000 |
| Hungary | 118,121,668 | 1,446,906 | 85,193,768 | 36,897,440 | ..... |
| Italy | 198,064,428 | 4,670,035 | 77,454,468 | 385,375,075 | 9,341,668 |
| Japan | 205,076,343 | See Col. 1 | 483,021,736 | 156,514,420 | 3,286,535 |
| Mexico | 37,963,823 | 743,508 | 1,087,300 | 70,766,739 | See Col. 4 |
| Netherlands | 80,455,526 | 540,113 | 54,492,724 | 164,793,766 | ..... |
| Norway | 30,695,300 | 202,600 | 4,199,700 | 4,321,200 | 57,300 |
| Portugal | 22,561,727 | 83,762 | 9,543,240 | 24,145,500 | 477,787 |
| Roumania | 11,751,558 | 1,121,401 | 14,057,882 | 24,908,318 | 207,451 |
| Russia | 300,822,581 | 5,476,878 | 97,701,412 | 80,444,160 | 4,190,274 |
| Spain | 122,590,854 | ..... | 13,681,624 | 194,884,182 | 99,985 |
| Sweden | 76,920,350 | 296,513 | 37,739,367 | 11,363,997 | 194,078 |
| Switzerland | 92,583,216 | 330,260 | 48,631,989 | 41,226,016 | ..... |
| United States of America | 3,732,031,938 | 139,151,837 | 740,087,805 | 3,306,582,333 | ..... |
| Uruguay | 3,350,544 | 31,189 | 167,407 | 14,442,140 | 362,042 |

* Figures cover both

eign letter from the mail, and in that case the deposit is $25. Any unexpended balance is, of course, returned.

FEES FOR MONEY ORDERS.

Payable in the United States (which includes Guam, Hawaii, Porto Rico and Tutuila, Samoa); also for Orders payable in Canada, Cuba, Newfoundland, the United States Postal Agency at Shanghai (China), the Philippine Islands, Barbados, Grenada, Saint Lucia, and St. Vincent.

For Orders for sums not exceeding $2.50, 3 cents.

Over $2.50 and not exceeding $5.00, 5 cents.

Over $5.00 and not exceeding $10.00, 8 cents.

Over $10.00 and not exceeding $20.00, 10 cents.

Over $20.00 and not exceeding $30.00, 12 cents.

Over $30.00 and not exceeding $40.00, 15 cents.

Over $40.00 and not exceeding $50.00, 18 cents.

Over $50.00 and not exceeding $60.00, 20 cents.

Over $60.00 and not exceeding $75.00, 25 cents.

Over $75.00 and not exceeding $100.00, 30 cents.

NOTE.—The maximum amount for which a single Money Order may be issued is $100. When a larger sum is to be sent additional Orders must be obtained. Any number of Orders may be drawn on any Money Order office; but, if Orders are drawn in excess of $200 on any one day upon an office of the 4th class, notice of the fact by letter (or Form 6037) is to be promptly sent the Department by the issuing Postmaster so that provision may be made for payment.

OF THE WORLD.

| Samples of merchandise. | Total of preceding columns, adding free matter, etc. | Ordinary Packages. | Money orders. | | Number of Letter Boxes. | Number of Employees. |
|---|---|---|---|---|---|---|
| | | | Number. | Value in Dollars. | | |
| 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| See Col. 4 | 319,119,054 | ..... | ..... | 2,130,321 | 2,519 | 6,163 |
| See Col. 5 | 333,558,972 | 1,099,384 | 2,165,016 | 16,761,631 | 7,878 | 15,492 |
| 14,449,000 | 836,380,800 | 25,751,600 | 25,833,578 | 237,803,784 | 30,996 | 58,888* |
| 4,782,544 | 453,433,761 | 3,412,268 | 1,525,197 | 36,898,771 | 8,500 | 7,371 |
| 1,623 | 1,231,264 | 18,373 | ..... | ..... | 457 | 921 |
| See Col. 4 | 554,156,454 | 1,621,646 | 13,640,140 | 86,551,999 | 51,347 | 60,174* |
| 50,830 | 22,226,790 | 110,371 | 225,243 | 4,207,871 | 2,412 | 1,781* |
| 58,404 | 58,805,378 | 584,986 | 329,282 | 3,598,348 | 1,130 | 2,175 |
| 6,736 | 3,844,132 | 63,482 | ..... | ..... | 162 | 215 |
| 121,360 | 11,893,177 | 10,624 | 64,710 | 2,076,036 | 1,111 | 767 |
| 293,720 | 83,761,851 | 2,685,320 | 2,616,660 | 17,938,179 | 10,531 | 7,011 |
| 8,139 | 1,329,444 | ..... | ..... | ..... | 112 | 132 |
| 110,000 | 25,150,000 | 200,500 | 503,500 | 12,584,000 | 1,317 | 1,590 |
| 51,024,069 | 2,113,656,692 | 44,638,979 | 43,473,736 | 304,135,418 | 68,156 | 81,659* |
| 46,997,370 | 3,781,632,920 | 183,994,828 | 159,117,620 | 2,390,185,643 | 126,481 | 241,967* |
| See Col. 5 | 4,053,600,000 | 87,014,292 | 104,201,954 | 357,210,065 | 58,873 | 183,595* |
| 2,170,864 | 290,196,722 | 9,316,406 | 15,857,701 | 157,812,182 | 11,237 | 22,582* |
| 10,021,951 | 747,040,295 | 9,243,969 | 15,295,051 | 200,800,478 | 23,760 | 30,925* |
| 2,781,546 | 882,765,664 | 9,519,910 | 9,203,258 | 47,752,424 | 51,058 | 57,965* |
| 664,662 | 120,887,017 | 251,556 | 920,824 | 41,811,849 | 1,142 | 10,477 |
| 1,802,204 | 311,406,621 | 4,537,142 | 4,159,398 | 24,616,865 | 4,583 | 8,364 |
| 164,400 | 43,830,800 | 334,500 | 289,722 | 6,050,873 | 4,070 | 3,673 |
| 697,515 | 60,208,773 | 253,806 | 296,410 | 4,082,509 | 6,097 | 6,525* |
| 369,845 | 43,643,104 | 133,514 | 860,694 | 5,951,183 | 4,903 | 6,886* |
| 3,510,005 | 591,932,272 | 2,495,802 | 16,916,041 | 377,446,238 | 21,065 | 57,962* |
| 915,180 | 350,692,763 | ..... | ..... | ..... | 8,979 | 5,293 |
| 623,510 | 132,704,875 | 983,668 | 3,078,112 | 24,764,948 | 5,648 | 8,246 |
| 385,545 | 198,682,821 | 18,045,172 | 6,472,827 | 133,719,746 | 10,349 | 12,324 |
| 84,798,683 | 8,002,652,596 | ..... | 40,474,327 | 325,925,666 | 129,335 | 239,652 |
| 32,116 | 18,801,025 | 9,800 | 38,174 | 4,204,775 | 1,016 | 1,582 |

post office and telegraph officials.

POSTAL SERVICE OF THE WORLD.—Continued.

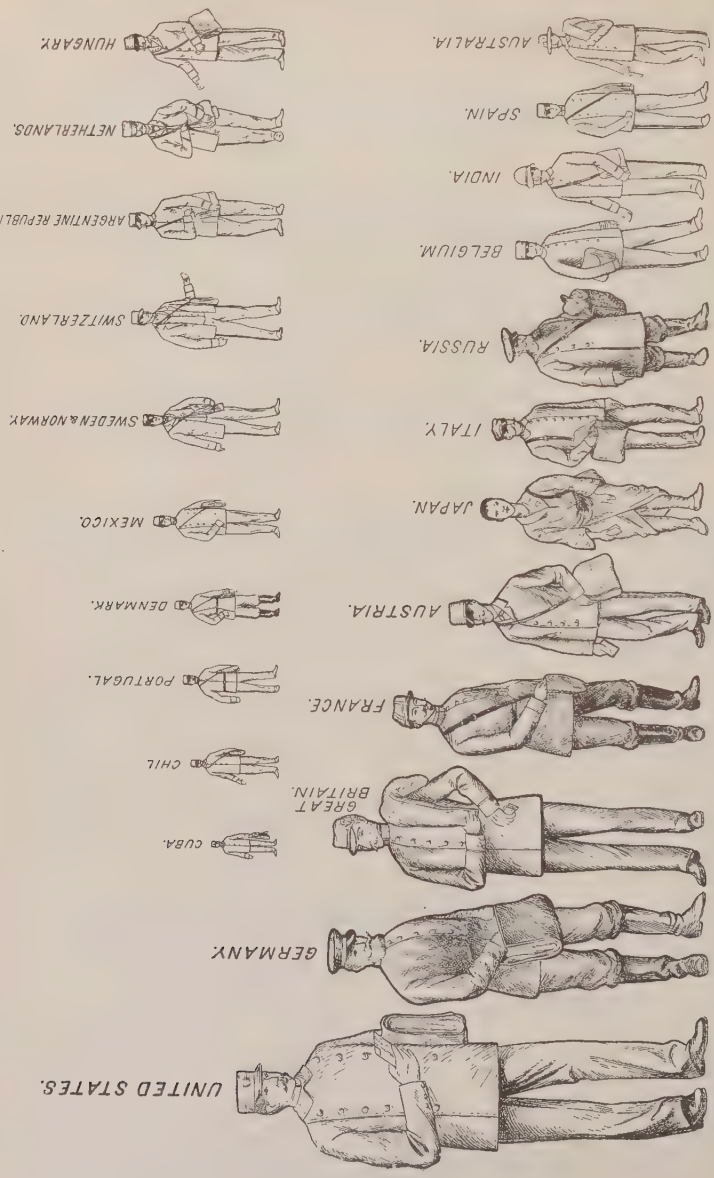
| Foreign postal matter sent out. | Number of letters. | | Number of post cards. | | Printed matter. | Commercial papers. | Samples of merchandise. | Total, including free matter. | Money orders. | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Postage prepaid. 1 | Not prepaid. 2 | Single 3 | With reply paid. 4 | 5 | 6 | 7 | 8 | Number 9 | Value in dollars. 10 |
| Argentine Republic | 4,686,577 | See col. 1 | 171,025 | See col. 3 | 2,282,204 | See col. 5 | See col. 5 | 7,144,691 | ..... | 89,161 |
| Australasia | 15,502,463 | See col. 1 | See col. 1 | See col. 1 | 14,976,730 | 4,214,096 | See col. 6 | 35,106,910 | 365,831 | 5,111,983 |
| Austria | 124,528,390 | 1,401,490 | 53,982,640 | 868,110 | 39,091,530 | 310,240 | 6,537,460 | 229,262,820 | 3,576,703 | 50,816,968 |
| Belgium | 25,430,678 | 196,703 | 8,843,185 | 50,479 | 22,204,728 | 290,290 | 1,488,422 | 58,595,551 | 502,297 | 5,322,398 |
| Bolivia | 154,208 | 1,140 | 7,487 | 91 | 60,591 | 1,690 | 366 | 228,498 | ..... | ..... |
| Bulgaria | 909,972 | 62,272 | 522,438 | 3,184 | 405,466 | 5,074 | 32,842 | 1,990,302 | 68,851 | 2,181,104 |
| Chili | 1,584,259 | 22,251 | 39,629 | 305 | 1,705,864 | 240 | 5,675 | 3,454,317 | 4,556 | 32,134 |
| Costa Rica | 109,040 | ..... | 11,381 | ..... | 118,870 | ..... | 1,490 | 244,249 | ..... | ..... |
| Cuba | 1,616,729 | 9,128 | 178,326 | ..... | 96,300 | 55,030 | 21,644 | 1,999,093 | 32,693 | 678,113 |
| Denmark | 7,285,924 | 41,010 | 1,812,480 | 23,088 | 1,640,760 | 35,996 | 174,444 | 11,013,702 | 195,616 | 1,947,634 |
| Dominican Republic | 57,920 | 3,813 | 3,953 | See col. 3 | 10,120 | ..... | 425 | 76,231 | ..... | ..... |
| Egypt | 3,015,000 | 40,000 | 420,000 | 5,000 | 1,500,000 | 15,000 | 100,000 | 5,100,000 | 112,000 | 1,976,000 |
| France | 71,921,364 | 487,500 | 3,065,808 | 113,143 | 76,814,171 | 837,294 | 5,647,705 | 158,886,985 | 1,875,680 | 18,855,293 |
| Germany | 130,554,980 | 1,516,550 | 36,489,670 | 357,330 | 66,254,950 | 728,200 | 7,456,740 | 243,937,970 | 2,908,116 | 28,256,389 |
| Great Britain | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | 686,740 | 9,523 196 |
| Hungary | 24,406,854 | 983,788 | 14,238,952 | 33,384 | 5,024,266 | 3,432 | 648,648 | 46,745,944 | 3,540,613 | 45,231,893 |
| India, British | 6,021,981 | See col. 1 | See col. 1 | See col. 1 | 2,920,279 | See col. 5 | See col. 5 | 8,942,260 | 114,982 | 1,931,883 |
| Italy | 26,558,615 | 1,789,318 | 3,990,808 | 112,938 | 7,953,757 | 199,788 | 1,346,238 | 42,032,857 | 221,277 | 2,352,639 |
| Japan | 3,460,633 | 26,169 | 959,840 | 4,798 | 2,125,612 | 24,667 | 101,374 | 6,776,575 | 8,381 | 126,380 |
| Mexico | 7,081,946 | 40,004 | 139,730 | 4,649 | 5,769,238 | See col. 5 | 205,324 | 13,316,256 | 14,958 | 479,196 |
| Netherlands | 13,620,907 | 194,430 | 5,303,677 | 64,922 | 8,673,815 | 118,834 | 1,481,757 | 29,491,093 | 321,427 | 2,569,450 |
| Norway | 4,446,884 | 69,293 | 767,546 | 2,821 | 1,014,441 | 34,047 | 64,935 | 6,425,707 | 158,936 | 1,243,609 |
| Portugal | 3,701,776 | 142,845 | 622 149 | 1,357 | 3,676,176 | 70,652 | 76,336 | 8,296,841 | 16,577 | 113,070 |
| Roumania | 4,011,212 | 232,580 | 2,530.331 | 20,376 | 1,474,714 | 103,177 | 456,535 | 8,882,806 | 359,801 | 3,203,887 |
| Russia | 22,140,299 | 1,180,71 ) | 8,678,178 | 422,382 | 7,795,650 | 384,604 | 1,326,859 | 41,928,691 | 14,535 | 239,091 |
| Spain | 19,107,072 | 207,384 | 2,287,278 | 7,152 | 17,596,768 | 62,390 | 475,542 | 39,751,296 | ..... | ..... |
| Sweden | 6,528,950 | 393,900 | 1,465,777 | 3,055 | 1,337,232 | 46,345 | 77,805 | 9,891,050 | 202, 783 | 1,805,450 |
| Switzerland | 20,789,204 | 416,989 | 19,981,009 | 60,685 | 10,800,851 | 163,538 | 1,489,185 | 53,823,555 | 1,065,976 | 8,228,494 |
| United States of America | 79,200,022 | 1,568,892 | 5,737,464 | 56,604 | 97,497,965 | 343,814 | 1,444,790 | 186,370,315 | 1,311,111 | 23,600,491 |
| Uruguay | 971,364 | 19,001 | 126,595 | ..... | 3,918,436 | 1,064 | 6,690 | 5,045,258 | 2,606 | 49,898 |

POSTAL SERVICE OF THE WORLD.—Continued.

| Foreign postal matter received. | Number of letters. | | Number of post cards. | | Printed matter. | Commercial papers. | Samples of merchandise. | Total, including free matter. | Money orders. | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Postage prepaid. 1 | Not prepaid. 2 | Single. 3 | With reply paid. 4 | 5 | 6 | 7 | 8 | Number. 9 | Value in dollars. 10 |
| Argentine Republic | 13,511,247 | See col. 1 | 36,006 | See col. 3 | 10,209,011 | See col. 5 | See col. 5 | 23,762,298 | ..... | ..... |
| Australasia | 17,577,805 | See col. 1 | See col. 1 | See col. 1 | 16,657,084 | 2,233,228 | See col. 6 | 38,015,821 | 396,877 | 5,313,869 |
| Austria | 119,405,590 | 1,101,650 | 60,874,670 | 667,570 | 24,252,060 | 192,520 | 5,442,990 | 214,334,340 | 5,909,384 | 61,947,412 |
| Belgium | 20,337,668 | 482,196 | 7,838,636 | 20,644 | 14,464,320 | 284,856 | 1,538,784 | 45,062,212 | 441,353 | 5,277,914 |
| Bolivia | 193,594 | 2,234 | 13,509 | 101 | 259,909 | 37,037 | 6,759 | 515,141 | ..... | ..... |
| British India | 6,865,258 | See col. 1 | See col. 1 | See col. 1 | 9,281,797 | See col. 5 | See col. 5 | 16,147,055 | 263,270 | 4,660,721 |
| Bulgaria | 1,345,504 | 67,662 | 724,742 | 10,572 | 1,276,084 | 15,642 | 76,078 | 3,555,878 | 41,351 | 402 397 |
| Chili | 2,001,052 | 28,046 | 98,145 | 5,451 | 4,266,586 | 1,527 | 67,635 | 6,539,467 | 994 | 33,212 |
| Costa Rica | 197,862 | ..... | 11,298 | ..... | 247,148 | ..... | 3,821 | 460,583 | ..... | ..... |
| Cuba | 3,537,420 | 1,896 | 114,121 | ..... | 2,185,400 | 1,826,361 | 635,836 | 8,316,692 | 9,019 | 240,161 |
| Denmark | 6,693,308 | 42,948 | 1,872,420 | 7,080 | 2,361,356 | 56,144 | 423,352 | 11,456,608 | 246,067 | 1,724,828 |
| Dominican Republic | 106,230 | 7,319 | 5,377 | See col. 3 | 104,087 | ..... | 2,838 | 225,851 | ..... | ..... |
| Egypt | 3,315,000 | 70,000 | 356,000 | 4,000 | 3,400,000 | 20,000 | 80,000 | 7,250,000 | 13,900 | 282,100 |
| France | 66,809,935 | 483,611 | 2,836,641 | 122,179 | 40,491,570 | 641,451 | 2,870,703 | 114,256,090 | 1,714,945 | 28,290,545 |
| Germany | 123,450,700 | 1,354,880 | 34,961,840 | 245,410 | 59,234,080 | 682,500 | 8,003,450 | 228,447,000 | 3,916,215 | 39,061,374 |
| Great Britain | Included in figures on Int. service. | | | | | | | | 2,910,306 | 27,911,268 |
| Hungary | 27,189,624 | 338,286 | 15,545,478 | 40,222 | 8,046,922 | 3,198 | 820,804 | 53,346,932 | 2,591,239 | 31,824,739 |
| Italy | 25,941,120 | 1,355,326 | 3,436,230 | 125,500 | 8,122,360 | 183,540 | 1,395,615 | 40,662,995 | 1,008,874 | 11,780,269 |
| Japan | 4,011,770 | 41,437 | 849,004 | 3,709 | 1,840,648 | 20,469 | 153,111 | 7,010,517 | 51,870 | 1,963,742 |
| Mexico | 5,511,488 | 107,163 | 340,542 | 6,096 | 25,465,222 | See col. 5 | 438,672 | 31,953,199 | 9,587 | 450,699 |
| Netherlands | 16,392,106 | 311,690 | 5,979,227 | 45,497 | 10,427,707 | 109,984 | 1,096,126 | 34,390,463 | 373,467 | 3,655,379 |
| Norway | 6,794,500 | 77,300 | 1,059,400 | 3,500 | 2,567,000 | 24,300 | 294,500 | 10,827,500 | 113,039 | 1,856,273 |
| Portugal | 3,956,190 | 41,185 | 422,466 | 2,028 | 2,642,498 | 92,762 | 156,305 | 7,330,100 | 19,319 | 429,118 |
| Roumania | 5,180,241 | 285,700 | 2,195,910 | 16,828 | 3,002,292 | 67,778 | 327,016 | 11,098,392 | 61,247 | 701,245 |
| Russia | 26,815,766 | 473,426 | 9,432,729 | 325,846 | 15,125,101 | 389,037 | 1,755,096 | 54,317,001 | 72,010 | 1,763,130 |
| Spain | 12,431,394 | 138,126 | 1,941,136 | 10,746 | 23,263,500 | 68,862 | 482,322 | 38,350,414 | ..... | ..... |
| Sweden | 11,004,586 | 125,896 | 1,802,953 | 2,756 | 3,675,479 | 28,899 | 454,168 | 17,134,842 | 201,186 | 3,311,638 |
| Switzerland | 22,742,759 | 966,524 | 12,506,689 | 49,397 | 15,367,755 | 154,986 | 1,384,721 | 53,257,968 | 635,454 | 5,833,775 |
| United States of America | 67,537,159 | 3,445,889 | 4,523,430 | 45,583 | 48,534,193 | 124,414 | 1,213,343 | 125,933,172 | 307,679 | 6,032,881 |
| Uruguay | 1,389,997 | 50,372 | 140,728 | ..... | 4,266,552 | 454,644 | 49,323 | 6,352,746 | ..... | ..... |

NOTE.—This table does not include transit matter and matter sent out.

—*From Reports of the Universal International Postal Union.*




COMPARISON OF THE POSTAL SERVICE OF THE WORLD.

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## SUGGESTION TO THE PUBLIC ON POSTAL SUBJECTS.

How to Direct and Mail Letters.—Mail matter should be addressed legibly and completely, giving the name of the postoffice, county and State, and the postoffice box of the person addressed, if he has one; if to a city having a free delivery, the street and number should be added. To secure return to the sender in case of misdirection or insufficient payment of postage, his name should be written or printed upon the upper left-hand corner of all mail matter; it will then be returned to the sender, if not called for at its destination, without going to the Dead Letter Office, and, if a letter, it will be returned free.

Dispatch is hastened by mailing early, especially when large numbers of letters, newspapers or circulars are mailed at once.

When a number of letters or circulars are mailed together, addressed to the same destination, it is well to tie them in bundles with the addresses facing the same side. On letters for places in foreign countries, especially Canada and England, in which many postoffices have the same name as offices in the United States, the name of the country as well as postoffice should be given in full. Letters addressed, for instance, merely to "London," without adding "England," are frequently sent to London, Canada, and *vice versa*, thereby causing delay, and often serious loss. Letters addressed to Burlington, N. S. (Nova Scotia), often go to Burlington, New York, on account of the resemblance between S and Y when carelessly written.

Avoid Thin Envelopes.—Thin envelopes, or those made of weak or poor, unsubtantial paper, should not be used, especially for large packages. Being often handled, and subjected to pressure and friction in the mail bags, such envelopes are frequently torn open or burst, without fault of those who handle them. It is best to use Stamped Envelopes wherever it is convenient and practicable to do so.

Registered Valuable Matter.—All valuable matter should be registered. Registry fee is eight cents, which, with full postage, must be prepaid, and name and address of sender must be given on the outside of envelope or wrapper. Money should be sent by a money order or registered letter; otherwise it is liable to be lost.

The Convenience of Letter Boxes.—Patrons in cities where letter carriers are employed are advised to provide letter boxes at places or private residences, thereby saving much delay in the delivery of mail matter.

Affix Stamps Firmly.—Postage stamps should be placed upon the upper right-hand corner of the address side of all the mail matter, care being taken that they are securely affixed.

General Suggestions.—A subscriber to a newspaper or periodical who changes his residence and postoffice should at once notify the publisher, and have the publication sent to his new address.

Publishers and news agents mailing second-class matter in quantities, will facilitate its distribution, and often hasten its dispatch, by separating such matter by States and Territories and the larger cities.

Hotel Matter.—That is, matter addressed for delivery at hotels, should be returned to the postoffice as soon as it is evident that it will not be claimed. Proprietors of hotels, officers of clubs and boards of trade, or exchanges, should not hold unclaimed letters longer than ten days, except at the request of the person addressed, and should re-direct them for forwarding, if the present address is known; otherwise they should be returned to the postoffice.

Letters addressed to persons temporarily sojourning in a city where the Free Delivery System is in operation should be marked "Transient" or "General Delivery," if not addressed to a street and number or some other designated place of delivery.—Post Office Guide.

## THE UNITED STATES POST OFFICE.

### POSTAL REVENUE IN DETAIL FOR YEAR ENDING JUNE 30, 1904.

The postal revenue from all sources was as follows:

| | |
|---|---|
| Sale of stamps, stamped envelopes, newspaper wrappers, and postal cards | $131,943,132.55 |
| Second-class postage (pound rate) paid in money | 5,697,198.19 |
| Box rents | 3,111,573.58 |
| Revenue from money-order business | 2,528,402.64 |
| Letter postage paid in money, principally balances due from foreign postal administrations | 106,689.29 |
| Miscellaneous receipts | 87,872.64 |
| Fines and penalties | 85,552.68 |
| Receipts from unclaimed dead letters | 22,202.77 |
| Total receipts | $143,582,624.34 |

## EXPENDITURES IN DETAIL.

The expenditures of the postal service for the year are shown, by items, in the following statement:

| | |
|---|---|
| Transportation of mails on railroads | $38,556,551.62 |
| Compensation to postmasters | 22,273,343.90 |
| City free-delivery service | 20,561,208.01 |
| Compensation to clerks in post-offices | 19,231,873.47 |
| Rural free delivery | 12,640,070.35 |
| Railway-mail service | 12,105,549.77 |
| Transportation of mails on star routes | 7,025,123.97 |
| Railway post-office car service | 5,256,081.49 |
| Rent, light, and fuel for first, second, and third class post-offices | 2,642,549.17 |
| Transportation of foreign mails | 2,561,888.53 |
| Compensation to assistant postmasters at first and second class post-offices | 1,806,428.19 |
| Mail-messenger service | 1,148,258.79 |
| Transportation of mails—regulation, screen, or other wagon service | 1,070,314.39 |
| Manufacture of stamped envelopes | 798,798.77 |
| Transportation of mails on steamboats | 663,326.65 |
| Transportation of mails, electric and cable cars | 484,346.24 |
| Manufacture of postage stamps | 364,659.68 |
| Mail bags, cord fasteners, label cases, etc | 334,971.96 |
| Salaries of post-office inspectors | 312,442.16 |
| Miscellaneous items at first and second class offices | 245,461.95 |
| Pneumatic-tube service | 214,406.36 |
| Canceling machines | 174,651.45 |
| Registered-package, tag, official, and dead-letter envelopes | $169,999.50 |
| Wrapping twine | 164,869.11 |
| Payment of money orders more than one year old | 158,036.75 |
| Manufacture of postal cards | 157,952.33 |
| Per diem allowance of post-office inspectors | 154,440.00 |
| Balances due foreign countries | 133,938.93 |
| Transportation of mails, special facilities | 114,349.30 |
| Blanks, blank books, etc., for money-order service | 94,974.34 |
| Salaries of clerks and miscellaneous expenses, mail depredations, and post-office inspectors | 84,646.21 |
| Stationery for postal service | 74,860.40 |
| Wrapping paper | 54,978.92 |
| Mail locks and keys | 44,057.74 |
| Postmarking and rating stamps | 37,446.11 |
| Advertising at first and second class post-offices | 24,866.34 |
| Printing facing slips, slide labels, etc | 20,991.62 |
| Expenditures under 25 smaller items of appropriation (less than $20,000 each) | 144,822.83 |
| Total expenditures for the year | $152,107,537.30 |
| Add expenditures during the year on account of previous years | 254,579.40 |
| Total expenditures during the year | $152,362,116.70 |
| Excess of expenditures over receipts | 8,779,492.36 |
| Receipts | $143,582,624.34 |

## MONEY ORDER BUSINESS.

| | Number. | Amount. |
|---|---|---|
| Domestic money orders issued | 50,392,554 | $378,778,488.84 |
| International money orders issued | 2,208,344 | 42,550,150.71 |
| Domestic money orders paid and repaid | 50,550,368 | 378,511,407.13 |
| International money orders paid and repaid | 915,836 | 13,303,459.62 |

## NUMBER OF POST OFFICES, EXTENT OF POST-ROUTES, AND REVENUE AND EXPENDITURES OF THE POST OFFICE DEPARTMENT, INCLUDING AMOUNTS PAID FOR TRANSPORTATION OF THE MAIL, 1877, 1887, 1897, AND 1904.

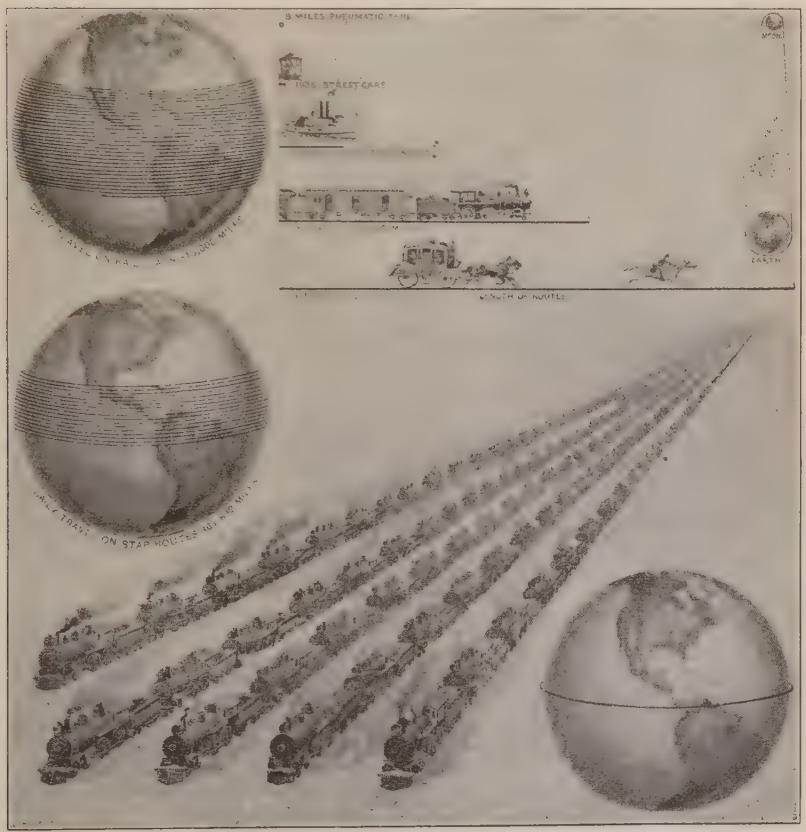
| Year ending June 30— | Post-offices. | Extent of post-routes. | Revenue of the Department. | Expended for transportation of— | | Total expenditure of the Department. |
|---|---|---|---|---|---|---|
| | | | | Domestic mail. | Foreign mail. | |
| | Number. | Miles. | Dollars. | Dollars. | Dollars. | Dollars. |
| 1877 | 37,345 | 292,820 | 27,531,585 | 18,774,235 | 448,896 | 33,486,322 |
| 1887 | 55,157 | 373,142 | 48,837,610 | 27,892,646 | 402,523 | 53,006,194 |
| 1897 | 71,022 | 470,032 | 82,665,463 | 48,028,094 | 1,890,099 | 94,077,242 |
| 1904 | 71,131 | 496,818 | 143,582,624 | 67,027,776 | 2,697,077 | 152,362,117 |

—From the Annual Reports of the Postmaster-General.

RAILROAD MILEAGE UPON WHICH MAIL WAS CARRIED, ANNUAL COST AND AVERAGE COST PER MILE OF RAILROAD MAIL TRANSPORTATION, AND EXPENDITURE FOR RAILWAY MAIL SERVICE EMPLOYEES.

| Year ending June 30. | Total railroads in operation in United States Dec. 31. | Railroads upon which mail was carried. | Annual transportation of mail by railroads. | Railroad mail transportation. | | Railway Mail Service. | |
|---|---|---|---|---|---|---|---|
| | | | | Annual cost of. | Average annual cost per mile. | Number of employees. | Annual expenditure. |
| | Miles. | Miles. | Miles. | Dollars. | Dollars. | | Dollars. |
| 1877... | 79,082 | 74,546 | 85,358,710 | 8,053,936 | .1060 | 2,500 | 2,484,846 |
| 1887... | 149,214 | 130,949 | 169,689,866 | 18,056,272 | .1064 | 4,851 | 4,694,562 |
| 1897... | 184,591 | 173,475 | 273,190,356 | 33,876,521 | .1240 | 7,602 | 7,782,547 |
| 1903... | 207,604 | 192,852 | 333,491,684 | 41,886,848 | .1256 | 10,418 | 11,250,042 |
| 1904... | ..... | 196,907 | 353,038,397 | 44,695,610 | .1266 | 11,444 | 12,095,437 |

—Prepared in the Office of the Postmaster-General.

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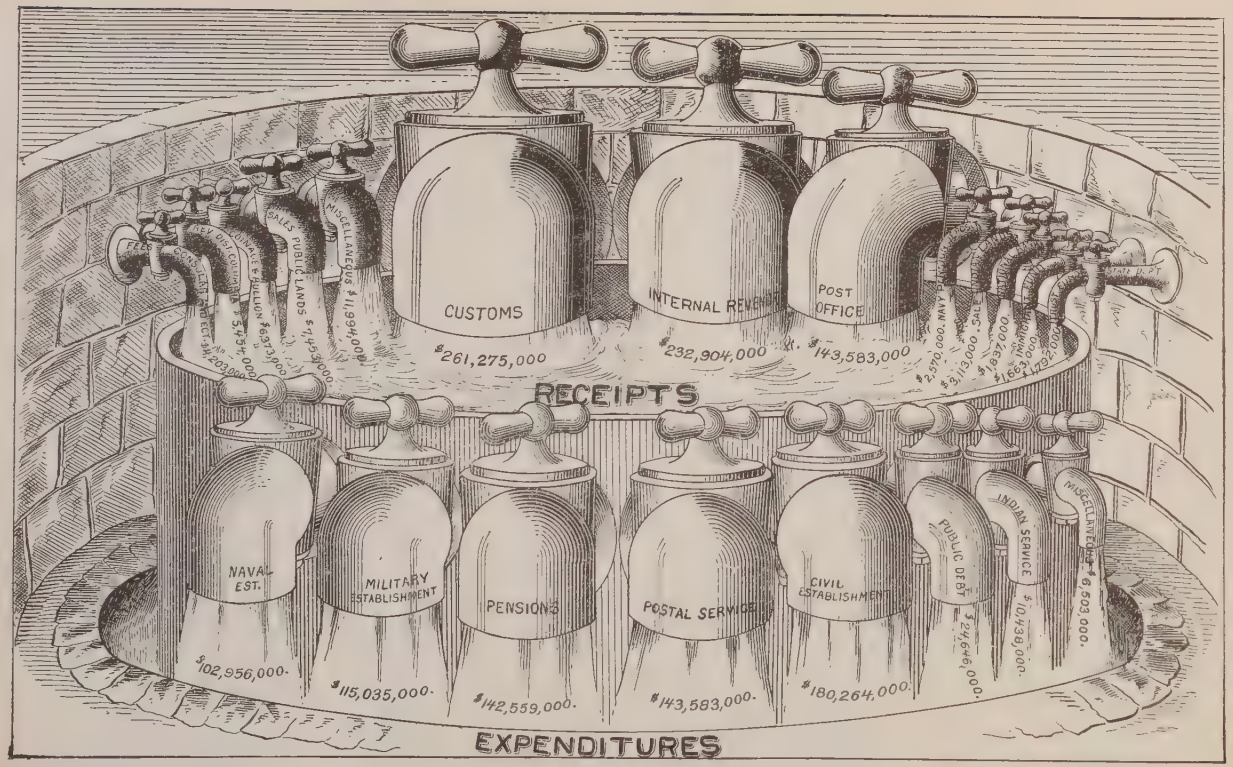
GRAPHICAL REPRESENTATION OF SOME INTERESTING STATISTICS OF THE U. S. POSTAL SERVICE, BASED ON FIGURES FOR 1901.

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RECEIPTS AND EXPENDITURES OF THE FEDERAL GOVERNMENT FOR THE FISCAL YEAR ENDING JUNE 30, 1904.

# CHAPTER XIII.

## INTERNATIONAL INSTITUTIONS AND BUREAUS.

### THE NOBEL PRIZES.

The Nobel Foundation is based upon the last will and testament of Dr. Alfred Bernhard Nobel, engineer and inventor of dynamite, dated November 27, 1895, the stipulations of which, respecting this fund, are as follows:

"The rest of my fortune, that is, the capital realized by my executors, is to constitute a fund, the interest of which is to be distributed annually as a prize to those who have in the course of the previous year rendered the greatest services to humanity. The amount is to be divided into five equal parts, one of which is to be awarded to the person who has made the most important discovery in the domain of physical science; another part to the one who has made the most valuable discovery in chemistry or brought about the greatest improvement; the third to the author of the most important discovery in the field of physiology or medicine; the fourth to the one who has produced the most remarkable literary work of an idealist tendency, and finally the fifth to the person who has done the best or the most in the cause of the fraternity of nations, for the suppression or the reduction of standing armies as well as for the formation and propagation of peace congresses. The prizes will be awarded for physics and chemistry by the Swedish Academy of Sciences; for works in physiology or medicine by the Caroline Institute of Stockholm; for literature by the Stockholm Academy, and finally for the service in the cause of peace by a Committee of five members of the Norwegian Storthing. It is my express desire that the benefits of the foundation are to be open to all nationalities and sexes and that the prize be awarded to the one most worthy, whether Scandinavian or not."

Each prize will amount to about $40,000, and the corporation will designate a "Comité Nobel" composed of three or five members for each section, with headquarters at Christiania, Norway.

The Swedish Academy of Sciences, Stockholm, awards the Physics and Chemistry Prizes; the Caroline Medical Institute, Stockholm, awards the Prize for Physiology or Medicine; the Swedish Academy in Stockholm awards the Literature Prize; and the Peace Prize is awarded by a Committee of five persons elected by the Norwegian Storthing. No consideration is paid to the nationality of the candidates, but it is essential that every candidate shall be proposed in writing by some qualified representative of science, literature, etc., in the chief countries of the civilized world, such proposals to reach the Committee before the first of February in each year, the awards being made on the following 10th of December. Nobel Institutes are to be established in each of the five departments, to carry out scientific investigations as to the value of the discoveries and improvements, and to promote the other objects of the Foundation.

The first distribution of prizes took place in 1901, the awards being: Peace, MM. Dunant and Passy; Medicine, Dr. Behring, of Marburg; Chemistry, Prof. J. H. van 't Hoff, Berlin; Physics, Prof. Röntgen; and Literature, M. Sully Prudhomme.

The 1902 Prizes were awarded as follows: Literature, Prof. Theodor Mommsen, of Berlin; Peace, MM. Ducommun and Gobat (Switzerland); Medicine, Major Ronald Ross, of the School of Tropical Medicine, Liverpool; Chemistry, Prof. Emil Fischer, of Berlin; Physics, divided between Profs. Lorentz and Zeemann, of Holland.

The 1903 Prizes were awarded thus: Peace, Mr. W. R. Cremer, M. P.; Literature, M. Björnson; Medicine, Prof. Finsen, of Copenhagen; Physics, Prof. Becquerel, of Paris, and Mme. Curié, of Paris; Chemistry, Prof. Arrhenius, of Stockholm.

All information can be obtained from Nobelstiftelsen, Stockholm, or as to the Peace Prize, from the Comité Nobel Norvégien, Victoria Terrasse, 7, III., Christiania.

## THE ANTHONY POLLOK PRIZE.

No doubt many inventors are wondering what disposition has been made of the Anthony Pollok Prize. Communications which have been received by the editor from Paris state that, owing to the unsatisfactory results of the former competition, the founders of the prize were undecided as to what should be done. Before taking any steps it was thought advisable to make an investigation. The Intermaritime Association in Paris sent out letters to the leading maritime associations, chambers of commerce and boards of trade of the principal maritime cities of the world, asking for advice as to the best methods to be pursued in order to obtain more satisfactory results in a possible future competition. Many replies were received and a large number of suggestions made.

A report containing the various recommendations and suggested changes was submitted by the Intermaritime Association but a short time ago. The founders of the Anthony Pollok Prize intend shortly to pass upon the report and adopt resolutions for the final disposition of the prize.

## INTERNATIONAL INSTITUTIONS AND BUREAUS.

Feeling that a large majority of our readers may not have access to the sources of information from which the following data are drawn, we take the liberty of presenting them with the most interesting facts concerning the origin and composition of some of the International Institutions and Bureaus in which the United States as a power, and we as a people, are interested.

### I. THE PERMANENT COURT OF ARBITRATION.

This court, more popularly known as The Hague Tribunal, was constituted by virtue of the convention for the pacific regulation of international questions, concluded at The Hague, July 29, 1899. (Office, Prinsegracht 71, The Hague.)

Administrative Council.—President: The Minister for Foreign Affairs for Holland. Members: The diplomatic representatives of all the signatory powers accredited to The Hague.

Members of the Permanent Court of Arbitration.—Since the individuals themselves are constantly changing by ill health or death, we shall content ourselves by giving the signatory powers alone, letting it suffice to say that these powers appoint their most distinguished men, preferably lawyers, to the position. They are: Austria-Hungary, Belgium, Bulgaria, Denmark, France, Germany, Great Britain, Greece, Holland, Italy, Japan, Luxemburg, Mexico, Portugal, Roumania, Russia, Servia, Spain, Sweden and Norway, Switzerland, and the United States.

### II. THE UNIVERSAL INTERNATIONAL POSTAL UNION.

The Universal Postal Union, founded by the Congress at Bern in 1874, constitutes a single territory for the reciprocal exchange of correspondence between the Postal Departments of the nations present at the Congress. Its scope has been further enlarged and developed by succeeding conventions and conferences at Bern (1876), Paris (1880), Lisbon (1885), Vienna (1891), and Washington (1897); today it comprises all the states and all the colonies having organized postal systems, including nearly the whole world.

To the chief convention of the Union, regulating the exchange of letters, postal cards, printed matter, official papers and samples have from time to time been added, special arrangements concluded between the most of the members having for their object the international interchange of letters and packages possessing a declared value, postal money orders, postal packages and collections, together with a passport service and a department for the subscription to journals and other publications.

A central office, created by the Congress at Bern, has its seat in that city and is known under the name of The International Bureau of the Universal Postal Union. It performs its labors under the supervision of the Swiss Postoffice Department. The ordinary annual expenses of this office were first fixed at 75,000 francs, later advanced to 100,000 and finally increased to 125,000 francs, by the Congress of Vi-

enna. The funds are provisionally advanced by the Swiss Government, which is reimbursed by all the contracting parties in proportion to their importance.

This bureau is charged with collecting, co-ordinating, publishing and distributing information of whatever nature appertaining to international postal affairs. Its duties are also to issue, upon the demand of any one of the members of the Union, a note upon questions in litigation, to examine into the demands for the modification of the acts of the Congress, to give notice of any adopted changes, and in general, to proceed with the studies and labors with which it is seized in the interest of the postal union. It prepares a table of general statistics for each year; it edits a special journal "L'Union postale" in the German, French, and English languages; it prepares the work of the Congresses or Conferences, publishes and keeps up to date a dictionary of all the postoffices in the world, and attends to the balancing and liquidation of the accounts between the various postal administrations which have declared their willingness to make use of it as an intermediary. The total amount of the liquidations in 1902 reached the considerable sum of 49,113,785.57 francs ($9,822,757.11). Throughout the territory controlled by the Union, 24,061,000,000 pieces were exchanged in 1901; of these 51 000,000 were letters and packages having a declared value of 45,283,000,000 francs ($9,056,600,000); 460,000,000 postal orders were sent, amounting to 24,147,000,000 francs ($4,829,800,000); moreover, 2,275,000 000 journals were delivered through the postal bureau for subscriptions to such publications.

### III. INTERNATIONAL BUREAU OF TELEGRAPHS.

This bureau is a central organ instituted in 1868 by the International Telegraphic Conference at Vienna and placed by it under the high direction of the superior authorities of the Swiss Confederation. Its object is to form a permanent bond between the telegraphic services of the different states which compose the Union, to facilitate the uniform application of the arrangements they have resolved upon, to collect and redistribute documents and information of mutual utility, to carry on such work and publications as are of interest to the service, notably to prepare work for the Conferences and publish their acts. This bureau has its seat in Bern, and its expenses are temporarily advanced by the Swiss Confederation, which is later reimbursed by the members of the Union, of whom there at present 47, covering a superficial area of 62,100,000 square kilometers, (23,970,000 square miles), and comprising within its circuits a population of 866,000,000 souls.

The recent Conference at London in 1903 simplified the matters of tariff and accounting very greatly. The participants in the benefits of this treaty are now: The whole of Europe, British India, the Dutch Indies, Ceylon, the Portuguese colonies in Asia, Siam, French Cochin-China, Persia, Japan, Asiatic Russia, and Asiatic Turkey, Egypt, Tunis, Cape Colony, Natal, East African colonies, and the British protectorate of Uganda, Portuguese East and West Africa, Madagascar, Algiers and Senegal, the Republics of Argentine, Brazil and Uruguay, the Australian Confederation, comprising South and West Australia, New South Wales, Queensland, Tasmania, Victoria, New Zealand and New Caledonia. Besides the countries above mentioned, the following are intimately connected with the general system which encircles the globe: China, the Philippines, British America, the United States, almost all the Greater and Lesser Antilles, Central and South America, Morocco at Tangier, the Azores, Island of Madeira, the Canaries and Cape Verde Islands, as well as those of Ascension and St. Helena, the Eastern and Western coasts of Africa, together with the islands of Seychelles, Maurice, Rodriguez, Cocos, and so forth.

It is estimated that the number of dispatches forwarded in 1901 by the countries above named amounted to more than 400,000,000.

### IV. INTERNATIONAL BUREAU OF WEIGHTS AND MEASURES.

By virtue of the Metric Convention signed at Paris, May 20, 1875, the States of Germany, Argentine Republic, Austria-Hungary, Belgium, Denmark, Spain, United States, France, Italy, Peru, Portugal, Russia, Sweden and Norway, Switzerland, and Venezuela, engaged to found and sustain, at common expense, an International Bureau of Weights and Meas-

ures, of which the seat should be at Sevres, near Paris. It is furthermore stipulated in that Convention, that the Bureau should perform its labors under the surveillance of an international committee, itself subject to a general Conference of weights and measures composed of all the delegates from the contracting States. This convention became operative from the first of January, 1876.

### V. INTERNATIONAL UNIONS FOR THE PROTECTION OF INDUSTRIAL, LITERARY AND ARTISTIC PROPERTIES.

The Union for the Protection of Industrial Property was founded at Paris, March 20, 1883, by a convention to which 19 States were parties. They were Belgium, Brazil, Denmark, France, Germany, Great Britain, Holland, Italy, Japan, Mexico, Norway and Sweden, Portugal, Servia, Spain, Santo Domingo, Switzerland, Tunis, and the United States. The object of the union is to assure the protection of inventions, designs and models of an industrial character, trademarks, firm names and indications of origin. This convention was completed and modified by an additional act signed at Brussels, December 14, 1900.

Moreover, on April 14, 1891, agreements were signed at Madrid constituting restrictive unions, viz.: 1. International registration of manufacturing and trademarks and the protection of these marks in all the contracting countries by the single registration at an International Bureau. The parties to this agreement were Belgium, Brazil, France, Holland, Italy, Portugal, Spain, Switzerland, and Tunis. 2. The suppression of false indications of origin: Brazil, France, Great Britain, Portugal, Spain, Switzerland, and Tunis. The arrangement of 1891, concerning the international registration of Marks, was completed and modified by an additional act signed at Brussels, December 14, 1900.

The Union for the Protection of Literary and Artistic Property, founded at Bern, September 9, 1886, comprised fourteen states: Belgium, Denmark, France, Great Britain, Germany, Haïti, Italy, Japan, Luxemburg, Monaco, Norway, Spain, Switzerland, and Tunis.

The object of this union is to assure effective protection to authors for their literary works, and to enable artists to enjoy the same security in their artistic productions throughout the whole territory covered by the union. This convention was completed and modified by an additional act and an interpretative declaration signed at Paris, May 4, 1896. Both of these unions are represented by a separate International Bureau established at Bern, and placed under the same directorate.

### VI. BUREAU FOR THE REPRESSION OF THE SLAVE TRADE ON THE AFRICAN COAST.

This bureau was instituted in the execution of the General Act of the Conference of Brussels of the 2d of July, 1890, and attached to the Department for Foreign Affairs of Belgium.

Article 81.—The Powers will communicate to the greatest extent possible and with the least possible delay:

1. The text of the existing laws and administrative regulations or edicts for the application of the clauses of the present General Act.

2. Statistical information concerning the slave trade; slaves taken and freed; the traffic in arms and ammunition, and also in spirits.

Article 82.—The exchange of these documents and circulars will be centralized in a special bureau attached to the Department of Foreign Affairs at Brussels.

Article 84.—The documents and circulars shall be collected and periodically published, and forwarded to all the signatory powers.

Article 85.—The expenses of running the bureau, of correspondence, of translation and printing, shall be met by all the signatory powers, and recovered by the Department of Foreign Affairs at Brussels.

### VII. INTERNATIONAL UNION FOR THE PUBLICATION OF CUSTOMS TARIFFS.

The International Union for the Publication of Customs Tariffs was founded by an international convention, July 5, 1890, and concluded between fifty-two states and semi-independent colonies. The object of the union is to publish as promptly and as correctly as possible all the tariffs of the world in five languages, viz., English, French, German, Italian, and Spanish. The bureau has its seat at Brussels, and is under the direct control of the Government of Belgium. The members

of the bureau are delegates from the principal countries whose language is used in the publications.

VIII. INTERNATIONAL BUREAU OF RAILROAD TRANSPORTATION.

On October 14, 1890, an international convention upon the transportation of merchandise by railroad was concluded at Bern, between Germany, Belgium, France, Italy, Luxemburg, Holland, Austria-Hungary, Russia, and Switzerland. Denmark and Roumania came in later.

The object of this convention was to regulate the law governing international transportation between the directorates of the railways and the shippers. To facilitate the execution of this convention an international railway transportation bureau was instituted at Bern.

IX. CENTRAL BUREAU OF INTERNATIONAL GEODESY ESTABLISHED UPON THE TELEGRAPHBERG, NEAR POTSDAM.

This central bureau has existed since 1866. After the creation of the Prussian Geodetic Institute it was united with the latter in 1869. The object of the Geodetic Institute is to cultivate geodesy by scientific researches, to execute the astronomical and physical determinations which, joined with the geodetic determinations, may serve in the exploration of the surface of the earth, more particularly within Prussian territory.

The labors of the institute for the present bear more particularly upon the astronomical determinations of the vertical in longitude and latitude, as well as upon astronomical data upon as many points of the geodetic system as possible; moreover, upon the determination of zenithal distances for convenient points, also upon the determination of the density and force of gravitation; it devotes its attention, furthermore, to researches upon the mean level and variations in the sea-level; to the examining into the refraction of luminous rays by the atmosphere; finally, it is occupied with all theoretical and experimental researches which contribute to the examination of the surface and the geodesy of the country.

The Geodetic Institute is placed under the immediate supervision of the Minister of Ecclesiastical Affairs, Public Instruction, and Medical Affairs of Prussia.

The Academy of Sciences is the consulting organ of the Minister in all the important affairs of the Institute. Conformably to the conventions agreed upon between the contracting parties, the Institute performs the functions of a Central Bureau for international geodesy. The director of the bureau is at the same time director of the Institute.—Almanach de Gotha.

## CARNEGIE HERO COMMISSION.

Mr. Andrew Carnegie gave $5,000,000 for a fund to be known as the "Carnegie Hero Fund Commission," the interest being devoted to the reward of those who perform heroic acts. The fund became operative April 15, 1904, and no applications on account of heroic acts performed prior to that date will be considered. The headquarters of the fund are in Pittsburg.

## RHODES SCHOLARSHIPS.

By his will, Mr. Cecil Rhodes, in his desire to encourage and foster an appreciation of the advantages which will result from the union of the English-speaking people throughout the world, and to encourage in students from the United States of America an attachment to the country from which they have sprung, without withdrawing their sympathies from the land of their adoption or birth, directs his trustees to establish sixty colonial scholarships for male students of $1,500 each a year for three years at the University of Oxford, these colonial scholarships being spread over most of the colonies, twenty-four being allotted to South Africa.

Two Oxford scholarships are to be allotted to each of the existing States and Territories of the United States of America—104 in all. By a codicil executed in South Africa, Mr. Rhodes, after stating that the German Emperor had made instruction in English compulsory in German schools, establishes fifteen scholarships for students of German birth (five in each of the first three years after his death), of $1,250 each, tenable for three years, to be nominated by the German Emperor, for "a good understanding between

England, Germany, and the United States of America will secure the peace of the world, and educational relationships form the strongest tie."

So that the students who shall be elected to the scholarships shall not be merely bookworms, regard is to be had, not only to their "literary and scholastic attainments," but also to their "fondness of and success in manly outdoor sports, qualities of manhood, truth, courage, devotion to duty, sympathy for and protection of the weak, kindliness, unselfishness, and fellowship," moral force of character and instincts of leadership. "No student shall be qualified or disqualified for election to a scholarship on account of his race or religious opinions." The scholars are to be distributed among all the colleges of the University of Oxford, and there is to be an annual dinner of past and present scholars and trustees.

Dr. G. R. Parkin, Principal of the Upper Canada School, Toronto, was appointed organizing agent for the trustees.—"Daily Mail" Year Book.

## THE CARNEGIE INSTITUTION.

This institution was founded by Mr. Andrew Carnegie for the promotion of original research in science, literature and art. He set aside $10,100,000 for the purpose. The interest is used to conduct, endow and assist investigation in any department of science, literature, or art, and to this end co-operate with governments, universities, colleges, technical schools, learned societies, and individuals. The headquarters of the institution are in Washington. Prof. D. C. Gilman is the President, and Mr. Charles D. Walcott is the Secretary. Many grants have already been made, and the investigations have been important.

# CHAPTER XIV.

## MINES AND MINING.

### SUMMARY OF THE MINERAL PRODUCTION OF THE UNITED STATES IN 1902.

#### GENERAL REMARKS.

In 1902, for the third time, the total value of the commercial mineral production of the United States exceeded the enormous sum of $1,000,000,000. The exact figures for 1902 were $1,260,639,415 as compared with $1,086,584,851 in 1901, with $1,063,678,053 in 1900, and with $972,208,008 in 1899, a gain of 1902 over 1901 of $174,064,414, or 16.02 per cent; a gain of 1902 over 1900 of $196,961,362, or 18.52 per cent; and a gain of 1902 over 1899 of $288.431,407, or 29.67 per cent. Although this gain is not so great either actually or proportionally as was the gain in 1899, when the gain over 1898 was $273,601,810, or 39.17 per cent, it is sufficient to be worthy of note.

The notable gains and losses of the last two decades are as follows:

The largest actual gain was that of 1899 over 1898, $273.601,810, or 39.17 per cent; next, that of 1902 over 1901, $174,053,760. or 16.02 per cent; then the gain of 1895 over 1894, which was $94,215,822, or 17.88 per cent; then that of 1900 over 1899, $91,468,340, or 9.41 per cent; and the gain of 1887 over 1886, $74,927,880, or 16.81 per cent. In other years than those mentioned between 1880 and 1898 the gains were not noteworthy, and in some of the years, notably in 1884, the production decreased $40,451,968, or nearly 9 per cent. During the industrial depression of 1892-1895 the production would have been expected to decline, as it did, going from $648,895,031 in 1892 to $574,464.724 in 1893, and to $527.079.225 in 1894, and then rising to $621,295,047 in 1895, and not reaching the output of 1892 until 1898.

As heretofore, iron and coal are the most important of our mineral products. The value of the iron in 1902 was $372,775,000; the value of coal $367,032,069. Nearly all the important metals increased in both output and value; and among the less important metals, platinum, as compared with 1901, lost in both quantity and value even more than it gained in 1901 as compared with 1900, the production in 1902 being 94 ounces, valued at $1,014, as compared with 1,408 ounces, valued at $27,526, in 1901, with 500 ounces in 1900, and with 300 ounces in 1899. The fuels increased from $442,410,904 in 1901 to $469,078.647 in 1902, a gain of $26,667,743, or 6 per cent. Every variety of fuel increased in value except anthracite coal, which showed a decrease in quantity of 23,301,850 long tons and in value of $36,330,434. The average price of anthracite coal per long ton at the mine was $2.35, as against $2.05 in 1901—the highest figure then obtained since 1888—as compared with $1.85 in 1900, and with $1.80 in 1899; and the average price per ton for bituminous coal at the mine was $1.125, as compared with $1.047 in 1901. The increase in value of the bituminous coal output over 1901 was $54,436,434.

The gain of $174,064,414 in the total value of our mineral production is due to the increase in both metallic and nonmetallic products, the metallic products showing an increase from $518.266,259 in 1901 to $642,258,584 in 1902, a gain of $123,992,325, and the nonmetallic products showing an increase from $567,318,592 in 1901 to $617,380.831 in 1902, a gain of $50,072,089. To these products should be added estimated unspecified products, including building, molding and other sands reported to this office, the rare mineral molybdenum, and other mineral products, valued at $1,000,000, making the total mineral production for 1902 $1,260.639,415.

The manufacture of arsenious oxide, noted for the first time in the United

States in the report for 1901, was continued in increased proportions in 1902.

METALS.

*Iron and Steel.*—Twenty-two States made pig-iron in 1902, as against 21 in 1899 and 1900, and 20 in 1901. The total production of pig-iron in 1902 was 17,821,307 long tons, against 15,878,354 tons in 1901, 13,789,242 tons in 1900, 13,620,703 tons in 1899, 11,773,934 tons in 1898, and 9,652,680 tons in 1897. The production of 1902 shows an increase of 1,942,953 long tons, or 12.2 per cent, in quantity over the production of 1901, and in increase in value from $242,174,000 to $372,775,000, amounting to $130,601,000, or about 54 per cent. The average price per long ton of pig-iron increased from $15.25 in 1901 to $20.90 in 1902. The average prices per long ton in recent years have been as follows: 1900, $18.85; 1899, $18; 1897, $9.85; 1896, $10.47; 1895, $11.14; 1894, $9.76.

*Iron Ores.*—The production of iron ores in 1902 amounted to 35,554,135 long tons, as compared with 28,887,479 long tons, in 1901, a gain of 6,666,656 long tons, or 23 per cent. The value at the mines of the ore mined in 1902 was $65,412,950. As in the four previous years, the production of iron ores in 1902 in the United States has never been equaled by any other country. There were mined also in 1902, 13,275 long tons of manganiferous iron ore, valued at $52,371, which were used in the production of spiegeleisen.

*Gold.*—The production of gold in 1902, as reported by the Bureau of the Mint, was 3,870,000 fine ounces, valued at $80,000,000.

*Silver.*—The production of silver in 1902, as reported by the Bureau of the Mint, was 55,500,000 fine ounces; coining value, $71,757,575; commercial value, $29,415,000.

*Manganese Ores.*—The production of manganese ores increased from 11,995 long tons, valued at $116,722, in 1901, to 16,477 long tons, valued at $177,911, in 1902, an increase in quantity of 4,472 tons and in value of $61,189. The average price per ton was $10.74 in 1902, as compared with $9.73 in 1901 and with $8.52 in 1900.

*Copper.*—The copper mining industry suffered during 1902 from the reaction which followed the unsuccessful attempt in 1901 to maintain the metal at an artificial level. The production, however, increased from 602,072,519 pounds in 1901 to 659,508,614 pounds in 1902, an increase of 57,436,125 pounds, or about 9 per cent, in quantity, but decreased in value from $87,300,575 in 1901 to $76,568,954 in 1902, a decrease of $10,731,561, or about 12 per cent. Unless unforeseen events cause widespread or long stoppage at the mines, the production of copper in the United States will be considerably larger in 1903 than it has ever been.

*Lead.*—The production of lead has been almost exactly the same for the last three years, viz., 270,000 short tons in 1902, 270,700 short tons in 1901 and 270,824 short tons in 1900. The value of the production in 1902 was $22,140,000, as compared with $23,280,200 in 1901, and with $23,564,688 in 1900.

*Zinc.*—The production of zinc in 1902 showed a continued increase in quantity as compared with 1901 and 1900, the production being 156,927 short tons in 1902, as compared with 140,822 short tons in 1901 and with 123,000 short tons in 1900. The value of the zinc production in 1902 was $14,625,596, as compared with $11,265,760 in 1901 and with $10,654,196 in 1900.

*Aluminum.* — The production of aluminum during 1902 was 7,300,000 pounds, valued at $2,284,590, as compared with 7,150,000 pounds, valued at $2,238,000 in 1901, and with 7,150,000 pounds, valued at $1,920,000 in 1900.

*Platinum.*—The production of platinum from domestic ores in the United States during 1902 was 94 ounces, valued at $1,814, as compared with 1,408 ounces, valued at $27,526 in 1901.

*Quicksilver.* — The production of quicksilver during 1902 amounted to 34,291 flasks of 76½ pounds net, as compared with 29,727 flasks in 1901 and with 28,317 flasks in 1900. The value of the quicksilver produced in 1902 was $1,467,848, as compared with $1,382,365 in 1901 and with $1,302,586 in 1900. California reported 28,972 flasks in 1902, as compared with 26,720 flasks in 1901; and Texas reported 5,319 flasks in 1902, as against 2,932 flasks in 1901. In addition, the census reports 10,427 tons of crude or cinnabar, valued at $67,242, mined in California, and 1,300 tons of cinnabar, valued at $1,500, mined in Texas in 1902, but not roasted or treated, a total of 11,727 short tons of cinnabar, valued at

$82,242. The total production of both quicksilver and cinnabar in 1902 was therefore valued at $1,550,090.

*Lithium.*—The production of lithium minerals in 1902 was 1,245 short tons, valued at $25,750 at the railroad, a decrease of 505 tons in amount and of $17,450 in value as compared with the production of 1901, which was 1,750 tons, valued at $43,200. As far as can be ascertained the greater part of the lithium minerals mined during 1902 was not shipped. Although the price of these minerals was lower in 1902 than in 1901 for the same grade of mineral, there was apparently no increase in the home demand. There is, however, an increase in the demand for these minerals from foreign chemical manufacturers.

*Nickel.*—The production of metallic nickel in 1902 was 5,748 pounds, valued at $2,701, as compared with 6,700 pounds, valued at $3,551 in 1901.

*Antimony.*—No antimony was obtained from domestic ores during 1902. The antimony obtained from the smelting of foreign imported ores amounted to 657 short tons, valued at $129,126, and the antimony obtained from hard lead produced from foreign and domestic lead ores was 2,904 short tons, valued at $505,240, a total production for 1902 of 3,561 short tons, valued at $634,506, as compared with 2,639 short tons, valued at $539,902, in 1901. The estimated total amount of antimony available for consumption in 1902 was 6,255 short tons, including 2,694 short tons of imported antimony regulus, as compared with 4,475 short tons, including 1,837 short tons of imported antimony regulus in 1901, and with 6,053 short tons, including 1,827 short tons of imported antimony regulus in 1900.

*Bismuth.*—No bismuth ores were produced in the United States during 1902. The marketed output in 1901 was 318.6 short tons. The ore contained gold and silver, for which the producers were paid. As nearly as can be ascertained, the value of the output in 1901 was $80 per ton, not including charges for transportation or treatment.

*Molybdenum.*—The production of molybdenum in 1902 was approximately the same as that of 1901, but none of the product was shipped in 1902. The value of these molybdenum ores is very erratic, the highest price hitherto quoted being $1,500 per ton, and the lowest $100.

*Tungsten.*—The production of tungsten during 1902 was 184 short tons of crude ore, of which no more than a few tons were sold. This does not represent the amount of tungsten ore sold in 1902, for 76 tons of concentrated ore, mined in 1901, were sold in 1902. In 1901 the production amounted to 179 tons of concentrated ore, valued at $27,720. The larger part of the production of 1902 was from Colorado.

*Uranium and Vanadium.*—There was a marked increase in the production of uranium and vanadium minerals in 1902, which, as reported to the Survey, amounted to 3,810 short tons, valued at $48,125, or $12.62 per ton. This, of course, represents the crude ore. In 1901 the production was 375 tons of crude ore.

FUELS.

*Coal.*—For the first time in the history of the United States the production of coal reached a total of over 300,000,000 short tons, showing an actual output of 301,590,439 tons of 2,000 pounds, valued at $367,032,069. Of this total the output of anthracite coal amounted to 36,940,710 long tons (equivalent to 41,373,595 short tons), which, as compared with the production of 60,242,560 long tons in 1901, was a decrease of 23,301,850 long tons, or about 39 per cent. This decrease, as is well known, was due entirely to the suspension of operations by the strike in the anthracite region from May 10 to October 23, a little over five months. But for the strike the output for the year would probably have been over 65,000,000 long tons. The value at the mines of the anthracite coal in 1902 was $76,173,586, as against $112,504,020 in 1901, a loss of about 32.3 per cent. The average value of the marketed coal sold during the year at the mines was $2.35 per long ton, the value in 1901 having been $2.05.

The output of bituminous coal (which includes semi-anthracite and all semi-bituminous and lignite coals) amounted in 1902 to 260,216,844 short tons, valued at $290,858,483, as against 225,828,149 short tons, valued at $236,422,049 in 1901. The increase in the production of bituminous coal was, therefore, 34,388,695 tons in quantity and $54,436,434 in value.

Out of 30 States and Territories producing coal in 1902, seven—California, Michigan, New Mexico, Oregon, Pennsylvania, Texas and Washington—had smaller outputs than in 1901.

The production of bituminous coal in Pennsylvania in 1902 exceeded that of 1901 by 15,755,874 short tons, but was not sufficient to overcome the great loss in anthracite production. The States in which the more important increases occurred with the corresponding gains are as follows: Illinois, 5,547,751 short tons; Colorado, 2,314,412 short tons; Ohio, 2,444,577 short tons; Indiana, 2,268,371 short tons; Alabama, 1,490,865 short tons; Kentucky, 1,193,176 short tons.

*Coke.*—The coke production of the United States in 1902 exceeded that of any year in our history. The production, which includes the output from 1,663 retort or by-product ovens, amounted to 25,401,730 short tons, as compared with 21,795,883 short tons in 1901, and with 20,533,348 short tons in 1900. The increase in 1902 over 1901 amounted to 3,605,847 short tons, or 16.5 per cent. Large as this increase was, it was considerably less than it would have been had the transportation facilities been commensurate with the demand for coke and with the productive capacity of the ovens. The increase in the value of coke was even more noteworthy. The average price per ton at the ovens was the highest recorded in a period of twenty-three years, and the total value reached the high figure of $63,339,167, an increase over 1901 of $18,893,241, or 42.5 per cent. The value of the coal used in the manufacture of coke in 1902 exceeded that of 1901 by $7,932,563, from which it appears that the value of the coke product increased $10,970,681 over and above the increased value of the coal used in its production. In 1901 the highest price obtained for Connellsville furnace coke was $4.25. In September and October of 1902, while the contract coke was nominally quoted at $3 per ton, consumers were paying from $10 to $12 per ton for prompt delivery, and $15 was reported as paid for this fuel at one time. With the termination of the anthracite strike in the latter part of October prices for coke quickly declined, but in December of 1902 furnace coke for prompt delivery was still commanding $5 and $6 per ton, and contracts for delivery in the first six months of 1903 were made at from $3.75 to $4 per ton.

*Gas, Coke, Tar and Ammonia.*—The aggregate value of all the products obtained from the distillation of coal in gas works or retort ovens in 1902 was $43,869,440. About two-thirds of this amount, or $29,342,881, was represented by the value of the gas produced. The value of the coke produced was $11,267,608, and the tar was worth, at the works, $1,873,966. The total quantity of ammoniacal liquor sold was 49,490,609 gallons, containing 14,683,374 pounds $NH_3$, and was worth at the works $1,065,300. In addition to this there was an actual production of 11,276,502 pounds of sulphate, which sold for $319,685.

*Petroleum.*—The total production of crude petroleum in the United States in 1902 was 88,766,916 barrels, as against 69,389,194 barrels in 1901, an increase of 19,377,722 barrels, or 27.92 per cent, over the production of 1901 and of 39.52 per cent over that of 1900. The greatest portion of the increase in 1902 came from Texas and California, the gain over 1901 being 13,690,000 barrels, or 311.6 per cent, for Texas, and 5,197,938 barrels, or 59.16 per cent, for California. The increase in Indiana in 1902 over 1901 was 1,723,810 barrels, or about 30 per cent. Louisiana produced for the first time in 1902, the production being 548,617 barrels. The increase over 1901 in the production of Kansas was 152,598 barrels, or about 85 per cent. Kentucky and Tennessee increased their production in 1902 by 48,072 barrels, or nearly 35.02 per cent. Indian Territory increased 37,000 barrels and Wyoming 853 barrels as compared with 1901. The largest decrease in production in 1902 as compared with 1901 was in West Virginia, where it amounted to 663,781 barrels, or about 4.5 per cent, and Ohio in 62 fields showed a decrease of 633,852 barrels, or nearly 3 per cent. The decrease in Pennsylvania was 561,888 barrels, or about 7 per cent; in Colorado, 63,619 barrels, or about 13.81 per cent. The percentages of production for fields show a remarkable change from 1900 to 1902. In 1900 the percentages were: Appalachian field, 57.05; Lima-Indiana field, 34.20; all other fields, 8.75. In 1902 the respective percentages were: Appalachian field, 36.07; Lima-Indiana field, 26.31; all other fields, about 37.62. The value of crude petroleum produced during 1902 was $71,178,910, or 80.19 cents per barrel, as compared with $66,417,335, or 95.7 per barrel, in 1901—a decrease of 15.51 cents per barrel, or 16 per cent, in 1902.

*Natural Gas.*—The value of the natural gas produced in 1902 increased to $30,867,668, as compared with $27,067,500 in 1901, with $23,698,674 in

1900, and with $20,074,873 in 1899—a gain of 13 per cent in 1902 over 1901.

STRUCTURAL MATERIALS.

*Stone.*—The value of all kinds of building stone produced in the United States during 1902 amounted to $64,559,099, as compared with $55,615,926 in 1901, with $44,321,345 in 1900, and with $44,090,670 in 1899.

*Clay Products.*—The activity in all branches of the clay-working industries noted in 1899, 1900 and 1901, continued during 1902. The value of all clay products as reported to the office of the Geological Survey in 1902 was $122,169,531, as compared with $110,211,587 in 1901, and with $96,212,345 in 1900. The brick and tile products in 1902 were valued at $98,042,078, as compared with $87,747,727 in 1901 and with $76,413,775 in 1900. The pottery products were valued in 1902 at $24,127,453, as compared with $22,463,860 in 1901 and with $19,798,570 in 1900.

The clay mined and sold by those not manufacturing the product themselves in 1902 was valued at $2,061,072, as compared with $2,576,932 in 1901 and with $1,840,377 in 1900.

*Cement.*—The total production of hydraulic cement in the United States in 1902 was 25,753,504 barrels, valued at $25,366,380, as compared with 20,068,737 barrels, valued at $15,786,789, in 1901, and with 17,231,150 barrels, valued at $13,283,581, in 1900. The Portland cement production in 1902 was 17,230,644 barrels, valued at $20,864,078, as compared with 12,711,225 barrels, valued at $12,532,360, in 1901, and with 8,482,020 barrels, valued at $9,280,525, in 1900, an increase, as compared with 1900, in quantity of about 100 per cent, and in value of over 50 per cent. The number of plants using Portland cement increased from 50 in 1900 to 56 in 1901, and to 65 in 1902. The production of natural rock cement in 1902 was 8,044,305 barrels, valued at $4,076,630, as compared with 7,084,823 barrels, valued at $3,056,278, in 1901, and with 8,383,519 barrels, valued at $3,728,848, in 1900. The production of slag cement amounted to 478,555 barrels, valued at $425,672, in 1902, as compared with 272,689 barrels, valued at $198,151, in 1901, and with 365,611 barrels, valued at $274,208, in 1900.

ABRASIVE MATERIALS.

*Carborundum.*—There was a slight decrease in the quantity of carborundum—3,741,500 pounds produced in 1902, as compared with 3,838,175 pounds in 1901—due in part to lack of a sufficient supply of raw materials, a result of the anthracite coal strike. The value of the carborundum varies from 8 to 10 cents per pound.

*Corundum and Emery.*—The combined production of corundum and emery in 1902 amounted to 4,251 short tons, valued at $104,605, as compared with 4,305 short tons, valued at $146,040, in 1901, a decrease of 54 tons in quantity and of $41,435 in value.

*Crushed Steel.*—The production of crushed steel in 1902 was 735,000 pounds, as compared with 690,000 pounds in 1901, and the product is quoted at 5½ cents per pound free on board at Pittsburg.

*Crystalline Quartz.*—In 1902 the production of crystalline quartz included under abrasives amounted to 15,104 short tons, valued at $84,335, as compared with 14,050 short tons, valued at $41,500, in 1901. This large variation in value is due to the fact that in 1902 the value reported was in some cases that of the quartz after it had been crushed or ground. The actual value of the crude quartz produced in 1902 was $43,085.

*Garnet.*—The production of abrasive garnet in the United States during 1902 amounted to 3,926 short tons, valued at $132,820, as compared with 4,444 short tons, valued at $158,100, in 1901, and with 3,185 short tons, valued at $123,475, in 1900. As reported to the Survey the prices varied from $20 to $60 a ton, the highest price being obtained for the North Carolina garnet. The average value per ton of the production in 1902 was $35.10, as compared with $35.57 per ton in 1901 and with $38.77 in 1900.

*Grindstones.*—The total value of all kinds of grindstones produced during 1902 was $667,431, as compared with $580,703, in 1901, an increase of $86,728. The production of 1900, valued at $710,026, still remains the largest on record for any year. It should be remembered, however, that the price per ton has decreased from $15 to from $8 to $10, and that therefore the tonnage of grindstones used has correspondingly increased within the last few years. The imports for 1902 amounted in value to $76,906, as compared with $88,871 in 1901 and with $92,581 in 1900.

*Infusorial Earth and Tripoli.*—In 1902 the production of infusorial earth and tripoli amounted to 5,665 short

tons, valued at $53,244, including 175 short tons mined as a by-product and valued at $1,436, an increase of 1,645 tons in quantity and of $294 in value, as compared with the production of 4,020 tons, valued at $52,950, in 1901.

*Millstones and Buhrstones.*—The value of the production of millstones and buhrstones in 1902 was $59,808, an increase of $2,629 over the value of 1901, which was $57,179. The value for 1902 was almost twice the value of the production of 1900, which amounted to $32,858. From 1886 to 1894 there was a very large decrease—from $140,000 to $13,887—in the production of buhrstones. Since 1894 there has been a gradual increase in the production.

*Oilstones and Whetstones.*—There was a decided increase in the domestic commercial production of oilstones and whetstones during 1902, the value of which amounted to $221,762, as compared with $158,300 in 1901, an increase in 1902 of $63,462. Until 1902, the year of maximum production was 1899, when the value of the output amounted to $208,283. The crude production of oilstones and whetstones in 1902, as reported by the census, was valued at $113,968.

*Pumice.*—The volcanic ash deposits in Nebraska were worked to some extent in 1902, the product being used in the manufacture of certain soaps and scouring powders. The production of pumice amounted to 700 short tons, valued at $2,750.

CHEMICAL MATERIALS.

*Arsenious Oxide.*—The domestic production of arsenious oxide (white arsenic) in 1902 was 1,353 short tons, valued at $81,180, as compared with 300 short tons, valued at $18,000, in 1901. The entire product was made by the Puget Sound Reduction Company at Everett, Wash., which began the manufacture of this important substance in 1901. The largely increased output in 1902 is a sign of the success of the new industry.

*Borax.*—The reported returns for 1902 gave an aggregate commercial production of crude borax of 2,600 short tons, valued at $91,000, of refined borax and boric acid, amounting to 17,404 short tons, valued at $2,447,614, of which it was stated that 862 short tons, valued at $155,000, were boric acid. This gives a total production for 1902 of 20,004 short tons, valued at $2,538,614. The production during 1901 was 17,887 short tons of crude borax and 5,344 short tons of refined borax, with a total value of $1,012,118.

*Bromine.*—The production of bromine in 1902, including the amount of bromine contained in potassium bromide, amounted to 513,890 pounds, valued at $128,472, as compared with 522,043 pounds, valued at $154,572, in 1901, a decrease for the year of 38,153 pounds in quantity and of $26,100 in value. The price per pound during 1902 averaged 25 cents, as compared with 28 cents in 1901 and with 29 cents in 1900. There has been practically no change in the bromine industry in the United States in 1902.

*Fluorspar.*—There was a large increase in the production of fluorspar in 1902 over that of 1901, due partly to its increased use for metallurgic purposes. The total production in 1902 was 48,018 short tons, valued at $271,832, as compared with 19,586 tons, valued at $113,803, in 1901. This increase in production was not due to any one State, but there was a large increase in production in both Illinois and Kentucky, and also an increase in Arizona. The average price of crude fluorspar was reported as $5.19 per ton, as compared with $5 in 1901, and the average price of ground fluorspar was $9.98 per ton, as compared with $9.22 in 1901. In addition to this production there were 800 short tons, valued at $3,850, mined but not marketed in 1902.

*Gypsum.*—The production of gypsum, particularly for the manufacture of calcined plaster, continues to show a remarkable gain. The output of crude gypsum in 1902 was 816,478 short tons, valued in its first marketable condition at $2,089,341, as compared with 633,791 short tons, valued at $1,506,641, in 1901, and with 595,462 short tons, valued at $1,627,203, in 1900. The production in 1899 was 486,235 short tons, and in 1898 it was 291,638 short tons. The greatly increased production of the last four years is attributable to the largely increased use of plaster of paris in the large modern buildings and in the manufacture of staff for temporary buildings.

*Marls.*—The production of marls in the United States in 1902 was 12,439 short tons, valued at $12,741.

*Phosphate Rock.*—The total commercial production of phosphate rock reported to the Survey in 1902 amounted to 1,490,314 long tons, val-

ued at $4,693,444, as compared with 1,483,723 long tons, valued at $5,316,403, in 1901, an increase in quantity of 6,591 tons and a decrease in value of $622,959. The total quantity of phosphate rock reported as mined during 1902 was 1,548,720 long tons, valued at $4,922,943, as compared with 1,440,408 long tons in 1901.

*Salt.*—The salt product includes salt in the form of brine used in large quantities for the manufacture of soda ash, sodium bicarbonate, caustic soda and other sodium salts. The domestic production of salt in 1902 amounted to 23,849,221 barrels of 280 pounds net, valued at $5,668,636, as compared with 20,556,661 barrels, valued at $6,617,449, in 1901, and with 20,869,342 barrels, valued at $6,944,603, in 1900.

*Sulphur and Pyrite.*—The domestic production of sulphur and of pyrite for the manufacture of sulphuric acid amounted in 1902 to 207,874 long tons, valued at $947,089, as compared with a combined production of 241,691 long tons, valued at $1,257,879, in 1901. The production of sulphur was from Louisiana, Nevada and Utah, named in the order of the importance of their outputs. Oregon and Idaho reported no production in 1902. The greater part of the output of pyrite was derived from Virginia, Georgia, North Carolina, Colorado and Massachusetts, named in the order of production.

PIGMENTS.

*Barytes.*—The production of crude barytes in 1902 was considerably in excess of that of the year before, amounting to 61,668 short tons, valued at $203,154, as compared with 49,070 tons, valued at $157,844, in 1901. This is an increase of 12,598 tons in quantity and of $45,310 in value.

*Cobalt Oxide.*—The domestic production of cobalt oxide in 1902 was 3,730 pounds, valued at $6,714, as compared with 13,360 pounds, valued at $24,048, in 1901, a decrease in quantity of 9,630 pounds. All the cobalt oxide was obtained as a by-product in smelting lead ores at Mine La-motte, Mo.

*Mineral Paints.*—The Commercial production of mineral paints in 1902 amounted to 73,049 short tons, valued at $944,332, as compared with 61,460 short tons, valued at $789,962, in 1901. The production of crude mineral paints in 1902 is reported as 35,479 short tons, valued at $360,885, including 4,500 tons, valued at $18,000, of ocher and metallic paint reported as mined but not marketed in 1902.

*Zinc White.*—The production of zinc white in 1902 amounted to 52,645 short tons, valued at $4,016,499, as compared with 46,500 short tons, valued at $3,720,000 in 1901.

MISCELLANEOUS.

*Asbestos.*—The commercial production of asbestos in the United States in 1902 was chiefly from the mines at Sall Mountain, White County, Georgia, with smaller quantities from Hillsdale, Berkshire County, Massachusetts. This production was 1,005 short tons, valued at $16,200, an increase of 258 tons in quantity and of $2,702 in value over the production of 1901, which was 747 short tons, valued at $13,498. The production in 1900 was 1,054 short tons, valued at $16,310. In addition there were reported as produced but not marketed in 1902 1,500 short tons of crude asbestos, valued at $30,000.

*Asphaltum.*—Under this title are included the various bitumens or hydrocarbons not discussed under the heading "Petroleum" in the volume on Mineral Resources. The commercial production of asphaltum in 1902 was 105,458 short tons, valued at $765,048, as compared with 63,134 short tons, valued at $555,335, in 1901—a large increase, amounting in quantity to 42,324 short tons and in value to $209,713. The production of crude asphaltum in 1902 is reported as 66,238 short tons, valued at $236,728.

*Bauxite.*—In 1902 the production of bauxite increased to 29,222 long tons, valued at $128,206, as compared with 18,905 long tons, valued at $79,914, in 1901. Georgia yielded the greater bulk of the product, the remainder being supplied by Alabama and Arkansas.

*Chromic Iron Ore.*—California was the one State to produce any chromite during 1902, the quantity being 315 long tons, valued at $4,567, a decrease of 53 tons in quantity and of $1,223 in value, as compared with the production of 1901, which was 368 long tons, valued at $5,790.

*Feldspar.*—The production of feldspar in 1902 was 45,287 short tons, valued at $250,424, as against 34,741 short tons, valued at $220,422, in 1901.

*Fibrous Talc.*—This variety of talc or soapstone occurs in but one locality in the United States—Gouverneur, St. Lawrence County, New York. It

is used principally as makeweight in the manufacture of paper. In 1902 the production was 71,100 short tons, valued at $615,350, an increase of $131,750 in value and of only 1,900 tons in quantity, as compared with the production of 69,200 short tons, valued at $483,600, in 1901.

*Flint.*—The production of flint in 1902 was 36,365 short tons, valued at $144,209, as compared with 34,420 short tons, valued at $149,297, in 1901.

*Fuller's Earth.*—As reported for the Survey, the production of fuller's earth in 1902 showed a decrease in quantity and an increase in value, being 11,492 short tons, valued at $98,144, as compared with 14,112 short tons, valued at $96,835, in 1901. The maximum production of fuller's earth was obtained in 1897, when the production was 17,113 short tons.

*Glass Sand.*—The production of glass sand in 1902 was 943,135 short tons, valued at $807,797; the production of engine, furnace, building, molding and other sands, mined incidentally, was 904,776 short tons, valued at $615,817—a total production of 1,847,901 short tons of sand, valued at $1,423,614.

*Graphite.*—The commercial production of crystalline graphite during 1902 amounted to 3,936,824 pounds, valued at $126,144, as compared with 3,967,612 pounds, valued at $135,914, in 1901, and with 5,507,855 pounds, valued at $178,761, in 1900. The commercial production of amorphous graphite in 1902 was 4,739 short tons, valued at $55,964, as compared with 809 short tons, valued at $31,800, in 1901. The decline in value was due to a proportionate increase in the production of the lower grades. Considerable development and exploratory work was done during the year in Montana, Wyoming, North Carolina and New Mexico. In addition, 30,000 pounds of refined graphite, valued at $1,800, and 20,716 short tons of crude graphite, valued at $43,600, were reported as produced but not marketed in 1902. This gives a total production of 3,966,824 pounds of refined graphite and of 25,455 short tons of amorphous graphite, with a total value of $227,508, as produced in 1902. The production of artificial graphite was 2,358,828 pounds, valued at $110,700, the average price being 4.69 cents per pound, as compared with 2,500,000, valued at $119,000, in 1901, the average price being 4.75 cents per pound.

*Limestone for Iron Flux.*—The quantity of limestone used for fluxing in blast furnaces in 1902 was 11,878,675 long tons, valued at $5,271,252, as compared with 8,540,168 long tons, valued at $4,659,836, in 1901, and with 7,495,435 long tons, valued at $3,687,394, in 1900.

*Magnesite.*—The production of magnesite in the United States continues to be limited to California, and during the year 1902 the commercial production reported was 3,466 short tons, valued at $21,362—a large decrease as compared with the production in 1901, which was 13,172 short tons, valued at $43,057. Of the 1902 production, 380 tons, valued at $1,723, were sold in 1902, but were mined previously.

*Mica.*—The production of mica in 1902 was as follows: 373,266 pounds of plate or sheet mica, valued at $83,843; 1,028 short tons of scrap mica, valued at $13,081, and 372 short tons of rough mica, valued at $21,925—a total value of $118,849.

*Mineral Waters.*—The total production of mineral waters for 1902 was 64,859,451 gallons, valued at $8,793,761, as compared with 55,771,181 gallons, valued at $7,586,962, in 1901—a gain in quantity of 9,088,263 gallons and in value of $1,206,799.

*Monazite.*—The production of monazite is confined exclusively to North Carolina and South Carolina, by far the larger quantity being obtained from the former State, and in 1902 this amounted to 802,000 pounds, valued at $64,160, as compared with 748,736 pounds, valued at $59,262, in 1901—an increase in quantity of 53,264 pounds and in value of $4,898. The price per pound received by the miners for the monazite produced in 1902 varied from 2.5 to 8 cents, according to the percentage of thoria.

*Precious Stones.*—The value of the gems and precious stones found in the United States in 1902 was $328,450, as compared with $289,050 in 1901, with $233,170 in 1900, and with $185,770 in 1899. There has been a great advance in the lapidary industry in the United States since 1894. The fact that larger establishments have been formed, which are able to purchase the rough diamonds in greater quantities, has placed our American diamond cutters in a position equal to that held by the cutters of Amsterdam, Antwerp and Paris. The cutting of our native gems has also grown to the proportions of an industry, notably in the case of the beryls and the amethyst found in North Carolina and Connecti-

cut; the turquoise from New Mexico, Arizona, Nevada and California; the fine-colored and deep-blue sapphires found in Montana; the colored tourmalines of San Joaquin County, California; the chrysoprase mine of Visalia, Tulare County, California; the garnets of Arizona and New Mexico, and the pale-purple garnets of North Carolina.

*Rutile.*—The production of rutile in 1902 was less than in 1901.

*Soapstone.*—Exclusive of the production of fibrous talc from Gouverneur, New York, the production of talc and soapstone in 1902 amounted to 26,854 short tons, valued at $525,157, as compared with 28,643 tons, valued at $424,888, in 1901—a decrease of 1,789 tons in quantity and an increase of $100,269 in value. The output for 1900 was 27,943 short tons, valued at $383,541, and for 1899 it was 24,765 short tons, valued at $330,805.—Mineral Resources of the United States.

MINERAL PRODUCTS OF THE UNITED STATES FOR THE CALENDAR YEAR 1902.

| Product. | 1902. Quantity. | 1902. Value. |
|---|---|---|
| METALLIC. | | |
| Pig iron (spot value).....long tons... | 17,821,307 | $372,775,000 |
| Silver, coining value.....fine ounces... | 55,500,000 | 71,757,575 |
| Gold, coining value.....do.... | 3,870,000 | 80,000,000 |
| Copper, value at New York City.....lbs... | 659,508,644 | 76,568,954 |
| Lead, value at New York City.....short tons... | 270,000 | 22,140,000 |
| Zinc, value at New York City.....do.... | 156,927 | 14,625,596 |
| Quicksilver, value at San Francisco.....flasks... | [1] 34,291 | 1,467,848 |
| Aluminum, value at Pittsburg.....lbs... | 7,300,000 | 2,284,590 |
| Antimony, value at San Francisco.....short tons... | 3,561 | 634,506 |
| Nickel, value at Philadelphia.....lbs... | 5,748 | 2,701 |
| Tin.....do... | None. | ..... |
| Platinum, value (crude) at San Francisco.....troy ounces... | 94 | 1,814 |
| Total value of metallic products..... | ..... | $642,258,584 |
| NON-METALLIC (SPOT VALUES). | | |
| Bituminous coal.....short tons... | 260,216,844 | $290,858,483 |
| Pennsylvania anthracite.....long tons... | 36,940,710 | 76,173,586 |
| Natural gas..... | ..... | 30,867,668 |
| Petroleum.....bbls... | [2] 88,766,916 | 71,178,910 |
| Brick clay..... | ..... | 15,000,000 |
| Cement.....bbls... | 25,753,504 | 25,366,380 |
| Stone..... | ..... | 64,559,099 |
| Corundum and emery.....short tons... | 4,251 | 104,605 |
| Crystalline quartz.....do.... | 15,104 | [3] 84,335 |
| Garnet for abrasive purposes.....do.... | 3,926 | 132,820 |
| Grindstones..... | ..... | 667,431 |
| Infusorial earth and tripoli.....short tons... | 5,665 | 53,244 |
| Millstones..... | ..... | 59,808 |
| Oilstones, etc..... | ..... | [3] 221,762 |
| Arsenious oxide.....short tons... | 1,353 | 81,180 |
| Borax (refined).....do.... | [4] 17,404 | 2,447,614 |
| Borax (crude).....do.... | 2,600 | 91,000 |
| Bromine.....lbs... | 513,890 | 128,472 |
| Fluorspar.....short tons... | [5] 48,018 | 271,832 |
| Gypsum.....do.... | 816,478 | 2,089,341 |
| Lithium.....do.... | 1,245 | 25,750 |
| Marls.....do.... | 12,439 | 12,741 |

[1] In addition the census reports 11,727 short tons of cinnabar, valued at $82,242, as mined but not marketed in 1902.

[2] In addition the census reports 508,386 barrels of petroleum, valued at $218,829, as produced but not marketed in 1902.

[3] Value of crude production as reported by the census: Crystalline quartz, $43,085; oilstones, $113,968.

[4] Production in 1902, as reported by the census, 19,142 short tons, valued at $2,383,614.

[5] In addition the census reports 800 short tons of fluorspar, valued at $3,850, as mined but not marketed in 1902.

MINERAL PRODUCTS OF THE UNITED STATES FOR THE CALENDAR YEAR 1902.—*Continued.*

| Product. | | 1902. Quantity. | Value. |
|---|---|---|---|
| Phosphate rock | long tons | [6] 1,490,314 | $4,693,444 |
| Pyrite | do. | 297,874 | 947,089 |
| Salt | bbls. | 23,849,221 | 5,668,636 |
| Sulphur | short tons | (7) | (7) |
| Barytes (crude) | do. | 61,668 | 203,154 |
| Cobalt oxide | lbs. | 3,730 | 6,714 |
| Mineral paints | short tons | [8] 73,049 | 944,332 |
| Zinc white | do. | 52,645 | 4,016,499 |
| Asbestos | do. | [9] 1,005 | 16,200 |
| Asphaltum | do. | [10] 105,458 | 765,048 |
| Bauxite | long tons | 29,222 | 128,206 |
| Chromic iron ore | do. | 315 | 4,567 |
| Clay (all other than brick) | short tons | 1,455,357 | 2,061,072 |
| Feldspar | do. | 45,287 | 250,424 |
| Fibrous talc | do. | 71,100 | 615,350 |
| Flint | do. | 36,365 | 144,209 |
| Fuller's earth | do. | 11,492 | 98,144 |
| Glass sand | do. | 943,135 | 807,797 |
| Graphite (crystalline) | lbs. | [11] 3,936,824 | 182,108 |
| Graphite (amorphous) | short tons | 4,739 | |
| Limestone for iron flux | long tons | 11,878,675 | 5,271,252 |
| Magnesite | short tons | [12] 3,466 | 21,362 |
| Manganese ore | long tons | 16,477 | 177,911 |
| Mica (sheet) | lbs. | 373,266 | 83,843 |
| Mica (scrap) | short tons | 1,400 | 35,006 |
| Mineral waters | gallons sold | 64,859,451 | 8,793,761 |
| Monazite | lbs. | 802,000 | 64,160 |
| Ozocerite (refined) | do. | None. | |
| Precious stones | | | 328,450 |
| Pumice stone | short tons | 700 | 2,750 |
| Rutile | lbs. | (12) | |
| Soapstone | short tons | 26,854 | 525,157 |
| Uranium and vanadium | do. | 3,810 | 48,125 |
| Total value of non-metallic mineral products | | | $617,380,831 |
| Total value of metallic products | | | 642,258,584 |
| Estimated value of mineral products unspecified | | | 1,000,000 |
| Grand total | | | 1,260,639,415 |

[6] The total quantity of phosphate rock mined in 1902 was 1,548,720 long tons, valued at $4,922,943.

[7] Included under pyrite.

[8] Production of crude material of mineral paints was 35,479 short tons, valued at $360,885.

[9] In addition, 1500 short tons of crude asbestos, valued at $30,000, are reported by the census as mined but not marketed in 1902.

[10] The production of the crude material is reported by the census as 66,238 short tons, valued at $236,728.

[11] In addition, graphite to the value of $45,400 is reported as mined but not marketed in 1902.

[12] The magnesite actually mined in 1902 is reported as 3,086 short tons, valued at $19,639.

[13] Included under estimated unspecified products.

SPEEDS FOR GRINDING AND POLISHING, ETC.

| Speed of | Ft. per Min. |
|---|---|
| Large grindstones for polishing | 2,000 |
| Emery disks | 2,500 to 3,000 |
| Polishing large articles | 750 |
| Tool grinders | 650 |
| Circular saws for hot iron | 20,000 |
| Disintegrators | 10,000 |
| Plate-bending rolls | 4 |
| Millstones | 17 000 |
| Sack tackle | 50 |

DEPRECIATION OF MACHINERY, ETC., PER ANNUM ON FIRST COST.

| Machinery, etc. | Depreciation. | Wear and Tear. | Total. |
|---|---|---|---|
| Engines | 3% | 3 % | 6 % |
| Boilers | 7% | 3 % | 10 % |
| Machines | 5% | 3 % | 8 % |
| Millwork and gearing | 3% | 2½ % | 5½ % |
| Bands and belts | | 45 % | 45 % |

## MINES AND QUARRIES.

DETAILED SUMMARY, UNITED STATES: 1902.

| | |
|---|---|
| Number of mines, quarries, or wells | 151,516 |
| Number of operators | 46,858 |
| Salaried officials, clerks, etc: | |
| Total number | 38,128 |
| Total salaries | $39,020,552 |
| General officers— | |
| Number | 4,591 |
| Salaries | $8,218,541 |
| Superintendents, managers, foremen, surveyors, etc— | |
| Number | 15,538 |
| Salaries | $16,666,416 |
| Foremen, below ground*— | |
| Number | 6,863 |
| Salaries | $6,208,307 |
| Clerks— | |
| Number | 11,136 |
| Salaries | $7,927,288 |
| Wage-earners: | |
| Aggregate average number | 581,728 |
| Aggregate wages | $369,959,960 |
| Above ground— | |
| Total average number | 221,505 |
| Total wages | $125,086,530 |
| Engineers, firemen, and other mechanics— | |
| Average number | 60,859 |
| Wages | $44,478,246 |
| Miners, or quarrymen and stonecutters— | |
| Average number | 67,129 |
| Wages | $33,971,290 |
| Boys, under 16 years— | |
| Average number | 6,219 |
| Wages | $1,339,478 |
| All other wage-earners— | |
| Average number | 87,298 |
| Wages | $45,297,516 |
| Below ground— | |
| Total average number | 360,223 |
| Total wages | $244,873,430 |
| Wage-earners—Continued: | |
| Miners— | |
| Average number | 257,301 |
| Wages | $184,674,193 |
| Miners' helpers— | |
| Average number | 18,736 |
| Wages | $11,496,910 |
| Boys, under 16 years— | |
| Average number | 5,638 |
| Wages | $1,548,889 |
| All other wage-earners— | |
| Average number | 78,548 |
| Wages | $47,153,438 |
| Contract work: | |
| Amount paid | $20,677,938 |
| Number of employees | 21,183 |
| Miscellaneous expenses, total | $71,771,713 |
| Royalties and rent of mine and mining plant | $34,530,713 |
| Rent of offices, taxes, insurance, interest, and other sundries | $37,241,000 |
| Cost of supplies and materials | $123,814,967 |
| Product, value | $796,826,417 |
| Power: | |
| Total horsepower | 2,867,562 |
| Owned— | |
| Engines— | |
| Steam, number | 64,179 |
| Horsepower | 2,432,963 |
| Gas, or gasoline, number | 13,506 |
| Horsepower | 259,695 |
| Water wheels, number | 980 |
| Horsepower | 60,897 |
| Other power, number | 1,162 |
| Horsepower | 84,546 |
| Rented— | |
| Electric, horsepower | 23,556 |
| Other kind, horsepower | 5,905 |
| Electric motors owned, number | 2,893 |
| Horsepower | 130,494 |
| Supplied to other establishments, horsepower | 2,852 |

* Foremen here reported should be added to the number of wage-earners below ground in order to ascertain the actual number employed below ground.—Census Bulletin.

## CLAY PRODUCTS OF THE UNITED STATES IN 1902.

In 1902 there were produced 8,475,067 thousands of common brick. The value of this product was $48,885,869, and the average price per thousand was $5.77. The quantity of front brick produced was 458,391 thousands, valued at $5,318,008. The average price per thousand was $11.60. Of vitrified paving brick the amount produced was 617,192 thousands, valued at $5,744,530, the average price per thousand being $9.31. The value of fancy or ornamental brick was $806,453. The value of fire brick was $11,970,511. The value of stove lining was $630,924. The value of drain tile was $3,506,787. The value of sewer pipe was $7,174,892. The value of ornamental terra cotta was $3,526,906. The value of the clay products used in fire-proofing was $3,175,593. The value of tile other than drain tile was $3,622,863. The value of adobes, aquarium ornaments, boiler and locomotive brick and tile, burnt-clay ballast, carboy stoppers, chemical brick and tile; chimney blocks, pipe and tops; clay furnaces, retorts, and settings; conduits for underground wires, crucibles, curbing block, fire-clay insulators, fire mortar, flue lining, furnace brick and tile, gas logs, glass-house supplies, grave markers, ground fire brick, muffles, oven tile, paving block, porous cups, saggers, stone pumps, wall coping, web tile sewer, and well brick was $3,678,742. The value of the pottery produced was $24,127,453, making a grand total of all clay products of $122,169,531.—U. S. Geological Survey.

## PETROLEUM, CRUDE, QUANTITIES OF, PRODUCED, IMPORTED, EXPORTED, AND RETAINED FOR CONSUMPTION.

| Year Ending June 30— | Production.[1] | Net Imports. | Total. | Domestic Exports. | | | Remaining for Consumption. | Per Cent of Product Exported. |
|---|---|---|---|---|---|---|---|---|
| | | | | Crude. | Illuminating Reduced to Crude. | Total. | | |
| | Gallons. | Gallons. | Gallons. | Gallons. | Gallons. | Gallons. | Gallons. | |
| 1880 | 836,394,132 | . . . . . | 836,394,132 | 28,237,997 | 483,323,451 | 511,621,448 | 324,772,684 | 61.17 |
| 1890 | 1,476,867,546 | 721,932 | 1,477,589,478 | 95,450,653 | 688,546,171 | 783,996,824 | 693,592,654 | 53.09 |
| 1900 | 2,396,975,700 | 2 17,540 | 2,396,993,240 | 133,023,656 | 948,720,575 | 1,081,744,231 | 1,315,249,009 | 45.13 |
| 1904 | 4,219,376,154 | 2 67,374 | 4,219,443,528 | 114,576,920 | 975,746,166 | 1,090,323,086 | 3,129,120,442 | 25.84 |

[1] The production is of the calendar year preceding the fiscal year.

[2] Imports for consumption.

Production furnished by Office of United States Geological Survey.

## PRODUCTION OF GAS.

The total quantity of gas sold for lighting and heating, as reported to the Census in 1900 by 877 gas establishments from which returns were received, was 67,093,553,471 cubic feet. The total quantity of gas manufactured by companies as a by-product and disposed of was 1,171,942,697 cubic feet. A combination of this latter quantity with the quantity reported for gas companies shows that, in 1900, the total quantity sold was 68,265,496,168 cubic feet.

The price per 1,000 cubic feet varied from $0.832 in Pennsylvania to $4.50 in Nevada. Proximity to the coal and oil-producing districts gives to Pennsylvania the minimum average rate, while distance from source of supplies and limited transportation facilities are accountable for the high price in Nevada. These averages represent the price of all manufactured gas, both fuel and illuminating, as the quantity of each kind was not separately reported; this statement is necessary in order to obviate erroneous deductions. Idaho, Indian Territory, and Oklahoma have no gas plants.

The quantity of gas sold in New York city was 18,180,821,125 cubic feet, at an average price of $0.905 per 1,000, or $16,457,822 in the aggregate.

## DIMENSIONS OF THE EARTH.

According to Bessel, in the metric system.

Equatorial radius (large axis, one half), $a = 6{,}377{,}397.15$ m.

Polar radius (small axis, one half), $b = 6{,}356{,}078.96$ m.

Oblateness,

$$p = \frac{a-b}{a} = \frac{1}{299.1528} = 0.0033427731.$$

Eccentricity of the meridians of the earth,

$$e = \sqrt{\frac{a^2-b^2}{a^2}} = 0.08169683.$$

A meridian-degree at the equator = 110,563.68 m.

A meridian-degree at the pole = 111,679.90 m.

A degree of the equator = 111,306.58 m.

Meridian quadrant = 10,000,855.76 m.

A geographic mile = 1-15 degree of the equator = 7,420.4385 m.

Radius of the sphere having the same surface as the earth = 6,370,289.5 m.

Radius of the sphere having the same capacity as the earth = 6,370,283.2 m.

Area of the earth = 509,950,714 qkm.

Cubic contents of the earth = 1,082,841,320,000 ckm.

Gravity at the level of the sea for the geographical latitude $\phi$, $g = 9.7810m + 0.0503m \sin^2 \phi$.

Length of the seconds pendulum at the sea-level for the geographical latitude $\phi$, $l = 0.99102m + 0.00510m \sin^2 \phi$.

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BARBED WIRE.—A pound of barbed wire should measure 16½ feet, and an acre of ground will require 50⅔ lb. per line of fencing.

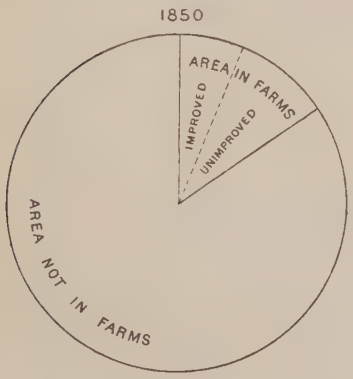
# CHAPTER XV.

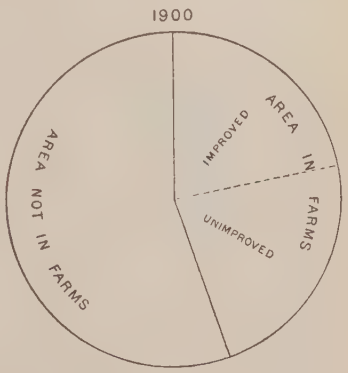
## FARMS AND FOOD.

### DIVISION OF THE UNITED STATES AS TO LAND.

Farms.—According to the Census of 1900 there are 5,737,372 farms having 414,498,487 acres of improved land and 424,093,287 acres of unimproved land. The value of all farm property was $20,439,901,164. The value of the land with improvements, including buildings, was $16,614,647,491. The value of implements and machinery was $749,775,970. The value of the live stock was $3,075,477,703. The average number of acres to a farm was 146.2 acres.

The total value of the product of all the farms was $4,717,069,973, and was divided as follows: Animal products, $1,718,365,561; crops, $2,998,704,612. Of the latter, $974,940,616 was fed to the live stock. The value of all live stock on farms and ranges was $2,979,197,586; poultry, $85,756,503; bees, $10,178,087.



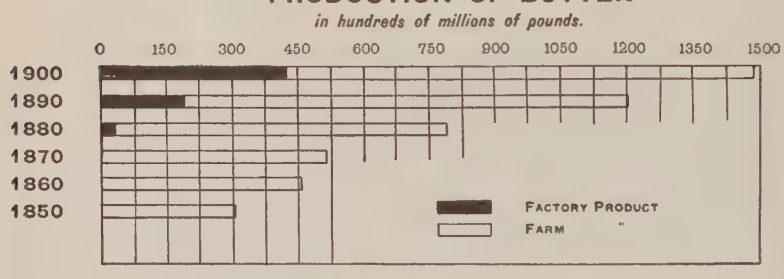



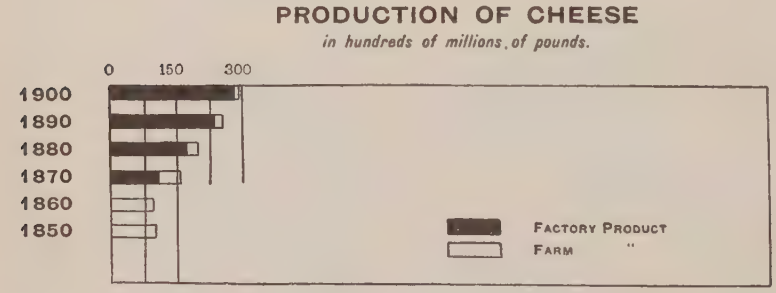

### THE POULTRY INDUSTRY.

Chickens form an essential part of the stock upon many farms. The Twelfth Census shows that there were 5,737,372 farms in the United States in 1900, and it is safe to say that those which did not have chickens among the stock were very few indeed. The Census also shows that there were 250,681,593 fowls (chickens, turkeys, geese, and ducks) in the United States. This gives an average of forty-two to every farm. The value of all fowls on farms in 1900 was $85,794,996, producing for market in one year poultry worth $136,891,877 and eggs worth $144,286,370, a total value of $281,178,547. The investment has yielded an income of 40 per cent. In seeking for the cause of the great success attending poultry raising, one must not overlook the great amount of work done by the mechanical incubator, which is not only as fully successful as the hen, but works on a large scale.

## DAIRY FARMS.

The Twelfth Census reports that in the year 1900 there were 5,739,657 farms in the United States, and of these 4,514,210 had dairy cows. Where a farm was found upon which at least 40 per cent. of the value of annual products was from dairy products, it was classified as a dairy farm. The total quantity of milk produced on farms in this country, during the year 1899, was 7,266,392,674 gallons, or, in round numbers, 62,500,000,000 pounds.




## MINERAL CONSTITUENTS ABSORBED OR REMOVED FROM AN ACRE OF SOIL BY THE FOLLOWING CROPS:

| Minerals. | Wheat, 25 Bushels. | Barley, 40 Bushels. | Turnips, 20 Tons. | Hay, 1½ Tons. |
|---|---|---|---|---|
| | Lbs. | Lbs. | Lbs. | Lbs. |
| Potassium | 29.6 | 17.5 | 47.1 | 38.2 |
| Sodium | 3. | 5.2 | 8.2 | 12. |
| Lime | 12.9 | 17. | 29.9 | 44.5 |
| Magnesium | 10.6 | 9.2 | 19.7 | 7.1 |
| Oxide of Iron | 2.6 | 2.1 | 7.1 | .6 |
| Phosphoric Acid | 20.6 | 25.8 | 46.3 | 15.1 |
| Sulphuric Acid | 10.6 | 2.7 | 13.3 | 9.2 |
| Chlorine | 2. | 16. | 3.6 | 4.1 |
| Silicium | 118.1 | 129.5 | 247.8 | 78.2 |
| Aluminum | ..... | 2.4 | ..... | ..... |
| Total | 210.00 | 213.00 | 423.00 | 209.00 |

## NUMBER AND VALUE OF DOMESTIC ANIMALS: 1900.

| Domestic Animals. | Age in Years. | Total. | | On Farms and Ranges. | | Not on Farms or Ranges. | |
|---|---|---|---|---|---|---|---|
| | | Number. | Value. | Number. | Value. | Number. | Estimated Value. |
| All domestic animals | | | Dollars. 3,193,856,459 | | Dollars. 2,979,197,586 | | Dollars. 214,658,873 |
| All neat cattle | | 69,335,832 | 1,516,307,270 | 67,719,410 | 1,475,204,633 | 1,616,422 | 41,102,637 |
| Calves | Under 1 | 15,577,728 | 139,638,829 | 15,315,582 | 137,290,001 | 262,146 | 2,348,828 |
| Steers | 1 & und'r 2 | 7,008,656 | 131,392,522 | 6,953,113 | 130,352,202 | 55,543 | 1,040,320 |
| Steers | 2 & und'r 3 | 5,244,011 | 152,871,930 | 5,193,006 | 151,386,664 | 51,005 | 1,485,266 |
| Steers | 3 and over | 3,179,069 | 113,123,532 | 3,073,267 | 109,366,503 | 105,802 | 3,757,029 |
| Bulls | 1 and over | 1,328,741 | 45,831,378 | 1,315,132 | 45,362,004 | 13,609 | 469,374 |
| Heifers | 1 & und'r 2 | 7,254,000 | 122,874,299 | 7,174,483 | 121,528,076 | 79,517 | 1,346,223 |
| Cows kept for milk | 2 and over | 18,108,666 | 537,496,120 | 17,135,633 | 508,616,501 | 973,033 | 28,879,619 |
| Cows not kept for milk | 2 and over | 11,634,961 | 273,078,660 | 11,559,194 | 271,302,682 | 75,767 | 1,775,978 |
| All horses | | 21,203,901 | 1,050,526,967 | 18,267,020 | 896,513,217 | 2,936,881 | 154,013,750 |
| Colts | Under 1 | 1,347,919 | 26,548,413 | 1,314,829 | 25,896,871 | 33,090 | 651,542 |
| Horses | 1 & und'r 2 | 1,476,627 | 49,313,762 | 1,446,225 | 48,298,639 | 30,402 | 1,015,123 |
| Horses | 2 and over | 18,379,355 | 974,664,792 | 15,505,966 | 822,317,707 | 2,873,389 | 152,347,085 |
| All mules | | 3,438,523 | 207,274,557 | 3,264,615 | 196,222,053 | 173,908 | 11,052,504 |
| Mule colts | Under 1 | 234,784 | 6,286,385 | 231,628 | 6,201,899 | 3,156 | 84,486 |
| Mules | 1 & und'r 2 | 283,829 | 11,937,495 | 279,501 | 11,755,416 | 4,328 | 182,079 |
| Mules | 2 and over | 2,919,910 | 189,050,677 | 2,753,486 | 178,264,738 | 166,424 | 10,785,939 |
| Asses and burros | All ages | 110,012 | 6,776,583 | 94,165 | 5,811,184 | 15,847 | 965,399 |
| All sheep | | 61,735,014 | 170,881,743 | 61,503,713 | 170,203,119 | 231,301 | 678,624 |
| Lambs | Under 1 | 21,702,447 | 42,116,628 | 21,650,746 | 42,016,328 | 51,701 | 100,300 |
| Sheep (ewes) | 1 and over | 31,997,274 | 101,732,728 | 31,857,652 | 101,288,730 | 139,622 | 443,998 |
| Sheep (rams and wethers) | 1 and over | 8,035,293 | 27,032,387 | 7,995,315 | 26,898,061 | 39,978 | 134,326 |
| Swine | All ages | 64,686,155 | 238,686,872 | 62,868,041 | 231,978,031 | 1,818,114 | 6,708,841 |
| Goats | All ages | 1,948,952 | 3,402,467 | 1,870,599 | 3,265,349 | 78,353 | 137,118 |

—From Reports of the Census.

## QUANTITY AND VALUE OF ANIMAL PRODUCTS OF FARMS: 1899.

| Product. | Unit of Measure. | Quantity. | Value. |
|---|---|---|---|
| Total | | | $1,718,365,561 |
| Wool | Pound | 276,567,584 | $45,670,053 |
| Mohair and goat hair | do. | 961,328 | 267,864 |
| Milk | Gallon | [1] 7,265,804,304 | |
| Butter | Pound | 1,071,626,056 | 472,276,783 |
| Cheese | do. | 16,372,318 | |
| Eggs | Dozen | 1,293,662,433 | 144,240,541 |
| Poultry | | | 136,830,152 |
| Honey | Pound | 61,099,290 | |
| Wax | do. | 1,763,595 | 6,656,611 |
| Animals sold | | | 722,614,328 |
| Animals slaughtered | | | 189,809,229 |

[1] Includes all milk produced.

—From Reports of the Census.

## ACREAGE, QUANTITY, AND VALUE OF FARM CROPS IN 1899.

From Reports of the Census.

| Crop. | Acres. | Unit of Measure. | Quantity. | Value. |
|---|---|---|---|---|
| Total | | | | $2,998,704,412 |
| Corn | 94,913,673 | Bushel | 2,666,324,370 | $828,192,388 |
| Wheat | 52,588,574 | do. | 658,534,252 | 369,945,320 |
| Oats | 29,539,698 | do. | 943,389,375 | 217,098,584 |
| Barley | 4,470,196 | do. | 119,634,877 | 41,631,762 |
| Rye | 2,054,292 | do. | 25,568,625 | 12,290,540 |
| Buckwheat | 807,060 | do. | 11,233,515 | 5,747,853 |
| Broom corn | 178,584 | Pound | 90,947,370 | 3,588,414 |
| Rice | 342,214 | do. | 250,280,227 | 6,329,562 |
| Kaffir corn | 266,513 | Bushel | 5,169,113 | 1,367,040 |
| Flaxseed | 2,110,517 | do. | 19,979,492 | 19,624,901 |
| Clover seed | | do. | 1,349,209 | 5,359,578 |
| Grass seed | | do. | 3,515,869 | 2,868,839 |
| Hay and forage | 61,691,069 | Ton | 84,010,915 | 484,254,703 |
| Cottonseed | | do. | [1] 4,566,100 | 46,950,575 |
| Cotton | 24,275,101 | Bale | 9,534,707 | 323,758,171 |
| Tobacco | 1,101,460 | Pound | 868,112,865 | 56,987,992 |
| Hemp | 16,042 | do. | 11,750,630 | 546,338 |
| Honey | | do. | 61,196,160 | |
| Hops | 55,613 | do. | 49,209,704 | 4,081,929 |
| Peanuts | 516,654 | Bushel | 11,964,109 | 7,270,515 |
| Peppermint | 8,591 | Pound | 187,427 | 143,618 |
| Dry beans | 453,841 | Bushel | 5,064,490 | 7,633,636 |
| Castor beans | 25,738 | do. | 143,388 | 134,084 |
| Dry pease | 968,370 | do. | 9,440,210 | 7,908,966 |
| Potatoes | 2,938,778 | do. | 273,318,167 | 98,380,110 |
| Sweet potatoes | 537,312 | do. | 42,517,412 | 19,869,840 |
| Onions | 47,981 | do. | 11,790,974 | 6,637,413 |
| Chicory | 3,069 | Pound | 21,495,870 | 73,627 |
| Milk | | Gallons | 7,266,392,674 | |
| Miscellaneous vegetables | 2,114,149 | | | 113,644,398 |
| Maple sugar | | Pound | 11,928,770 | 1,074,260 |
| Maple sirup | | Gallon | 2,056,611 | 1,562,451 |
| Sugar-cane | 386,986 | Ton | [2] 4,202,202 | |
| (*a*) Cane sold | | do. | 1,126,076 | 3,881,758 |
| (*b*) Cane kept for seed | | do. | 1,453,447 | 5,018,469 |
| (*c*) Sugar made | | Pound | 159,454,814 | 6,558,944 |
| (*d*) Molasses made | | Gallon | 6,312,809 | 788,990 |
| (*e*) Sirup made | | do. | 12,293,032 | 4,293,475 |
| Sorghum cane | 293,152 | Ton | [3] 291,703 | 815,019 |
| Sorghum sirup | | Gallon | 16,972,783 | 5,288,083 |
| Sugar beets | 110,170 | Ton | 793,353 | 3,323,240 |
| Small fruits | 309,770 | | | 25,029,757 |
| Grapes | | Cental | 13,009,841 | [4] 14,090,234 |
| Orchard products | | Bushel | 212,365,600 | [5] 83,750,961 |
| Subtropical fruits | | | | 8,227,838 |
| Nuts | | | | 1,949,931 |
| Forest products | | | | 109,864,774 |
| Flowers and plants | 9,307 | | | 18,758,864 |
| Miscellaneous seeds | 10,106 | | | 826,019 |
| Nursery products | 59,492 | | | 10,123,873 |
| Willows | 521 | | | 36,523 |
| Miscellaneous | 23,793 | | | [6] 1,120,343 |

[1] Not including 166,861 tons sold with fiber before ginning.

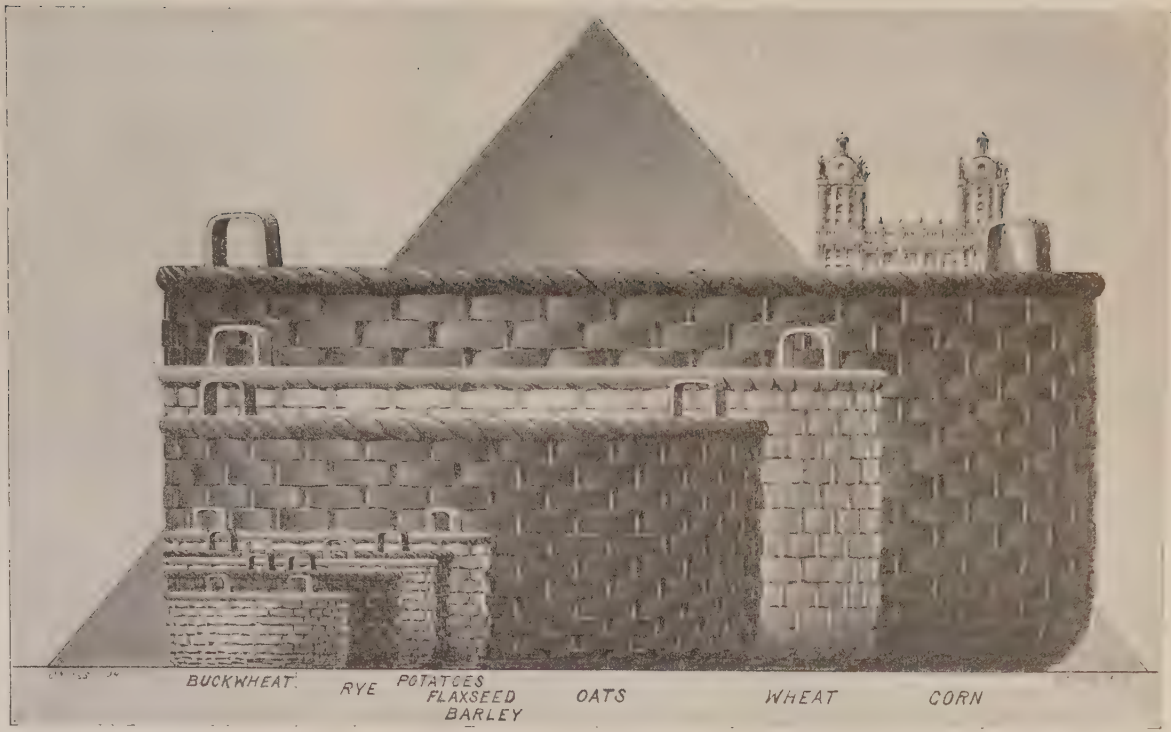
[2] Comprising all cane grown, whether sold as cane, kept for seed, or used in the manufacture of sugar, molasses, and sirup.

[3] Sold as cane.

[4] Including value of raisins, wine, etc.

[5] Including value of cider, vinegar, etc.

[6] The greater part of this value was derived from products for which no acreage was reported.

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COMPARISON OF PRINCIPAL CROPS OF THE UNITED STATES.

## FRUIT PRODUCTS.

(Abstracted from the United States Census Reports.)

| Product. | Unit of Measure. | Quantity. | Value. |
|---|---|---|---|
| Fruits (orchard) | Bushels | 212,366,646 | $83,751,840 |
| Apples | Bushels | 175,397,626 | |
| Apricots | Bushels | 2,642,128 | |
| Cherries | Bushels | 2,873,499 | |
| Peaches, etc | Bushels | 15,433,623 | |
| Pears | Bushels | 6,625,417 | |
| Plums, etc | Bushels | 8,764,032 | |
| Unclassified | Bushels | 630,321 | |
| Cider | Barrels | 1,754,927 | |
| Cider vinegar | Barrels | 392,497 | |
| Fruits (small) | Quarts | 431,628,520 | 25,030,877 |
| Blackberries | Quarts | 62,189,885 | |
| Currants | Quarts | 18,592,695 | |
| Gooseberries | Quarts | 9,320,530 | |
| Raspberries | Quarts | 76,628,107 | |
| Strawberries | Quarts | 257,437,523 | |
| Unclassified | Quarts | 7,459,780 | |
| Fruits (sub-tropical) | | | 8,549,863 |
| Bananas | Bunches | 141,653 | |
| Citrons | Boxes | 90 | |
| Figs | Pounds | 13,016,274 | |
| Guava | Pounds | 1,677,165 | |
| Lemons | Boxes | 876,978 | |
| Limes | Boxes | 24,375 | |
| Olives | Pounds | 5,053,637 | |
| Oranges | Boxes | 6,171,259 | |
| Persimmons | Pounds | 136,030 | |
| Pineapples | | 2,980,240 | |
| Pomeloes | Boxes | 30,791 | |
| Unclassified | Pounds | 2,969,239 | |
| Olive oil | Gallons | 8,643 | |
| Coffee | Pounds | 2,297,000 | 246,181 |

## STATISTICS OF PRINCIPAL CROPS.

| Crop. | Year. | Acreage. | Unit. | Average Yield per Acre. | Production. |
|---|---|---|---|---|---|
| Corn | 1903 | 88,091,993 | Bushel | 25.5 | 2,244,176,925 |
| Wheat | 1903 | 49,464,967 | " | 12.9 | 637,821,835 |
| Oats | 1903 | 27,638,126 | " | 28.4 | 784,094,199 |
| Barley | 1903 | 4,993,137 | " | 26.4 | 131,861,391 |
| Rye | 1903 | 1,906,894 | " | 15.4 | 29,363,416 |
| Buckwheat | 1903 | 804,393 | " | 17.7 | 14,243,644 |
| Potatoes | 1903 | 2,916,855 | " | 84.7 | 247,127,880 |
| Hay | 1903 | 39,933,759 | Ton | 1.54 | 61,305,940 |
| Cotton | 1902–1903 | 27,114,103 | Bale | | 10,725,422 |
| Tobacco | 1903 | 1,037,735 | Pound | 786.3 | 815,972,425 |
| Flaxseed | 1903 | 3,233,239 | Bushel | 8.4 | 27,300,510 |
| Sugar, beet and cane | 1903–1904 | | Long ton | | 423,135 |

STATISTICS OF PRINCIPAL CROPS—*Conttnued.*

| Crop. | Year. | Unit. | Average Farm Price. | Farm Value. | Exports, Bushels.[1] |
|---|---|---|---|---|---|
| Corn | 1903 | Bushel | 42.5 c. | $952,868,801 | 76,639,261 |
| Wheat | 1903 | " | 69.5 c. | 443,024,826 | 202,906,273 |
| Oats | 1903 | " | 34.1 c. | 267,661,665 | 8,381,805 |
| Barley | 1903 | " | 45.6 c. | 60,166,313 | 56,462 |
| Rye | 1903 | " | 54.5 c. | 15,993,871 | 5,445,273 |
| Buckwheat | 1903 | " | 60.7 c. | 8,650,733 | ..... |
| Potatoes | 1903 | " | 61.4 c. | 15,638,094 | 843,075 |
| Hay | 1903 | Ton | $9.08 | 556,376,880 | [2] 50,974 |
| Cotton | 1902–1903 | Bale | ..... | 458,051,005 | [3] 7,086,086 |
| Tobacco | 1903 | Pound | 6.8 c. | 55,514,627 | ..... |
| Flaxseed | 1903 | Bushel | 81.7 c. | 22,291,557 | ..... |
| Sugar, beet and cane | 1903–1904 | Long ton | ..... | ..... | ..... |

[1] Does not necessarily mean the crop year; in all cases one year and generally two years behind.
[2] Tons instead of bushels.
[3] 1902–1903.

## STATISTICS OF PRINCIPAL ANIMALS.

| Animals. | Year. | Number. | Value. |
|---|---|---|---|
| Horses | 1904 | 16,736,059 | $1,136,940,298 |
| Mules | 1904 | 2,757,916 | 217,532,916 |
| Cows | 1904 | 17,419,817 | 508,841,489 |
| Other cattle | 1904 | 43,629,438 | 712,178,134 |
| Sheep | 1904 | 51,630,144 | 133,530,099 |
| Hogs | 1904 | 47,009,367 | 289,224,627 |

## CUTS OF MEAT.

The method of dividing up the carcasses of slaughtered animals varies considerably in different localities. In order that there may be no confusion on this account the character of the cuts of beef, veal, pork and mutton is shown in the diagrams given on page 362.

## THE FUNCTIONS AND USES OF FOODS.

BY C. F. LANGWORTHY, PH. D.
*Office of Experiment Stations.*

In this article a number of the terms used in discussing food are defined and some of the principles of nutrition are briefly stated. The average composition of a number of the more common American foods is quoted as well as the commonly accepted dietary standards. With the aid of such data, the nutritive value of any given diet may be computed and its comparative value ascertained.

Ordinary food materials, such as meat, fish, eggs, potatoes, wheat, etc., consist of:

*Refuse.*—As the bones of meat and fish, shells of shellfish, skins of potatoes, bran of wheat, etc.

*Edible Portion.*—As the flesh of meat and fish, the white and yolk of eggs, wheat flour, etc. The edible portion consists of water and nutritive ingredients, or nutrients. The nutritive ingredients are *protein, fats, carbohydrates* and *mineral matters.*

The water, refuse, and salt of salted meat and fish are called non-nutrients. In comparing the values of different food materials for nourishment they are left out of account.

### USE OF NUTRIENTS.

Food is used in the body to build and repair tissue and to furnish energy. The manner in which the valuable constituents are utilized in the body may be expressed in tabular form as follows:

| | | |
|---|---|---|
| Protein. White (albumen) of eggs, curd (casein) of milk, lean meat, gluten of wheat, etc. | Forms tissue (muscles, tendon, and probably fat). | All serve as *fuel* and yield *energy* in form of heat and muscular strength. |
| Fats. Fat of meat, butter, olive oil, oils of corn and wheat, etc. | Form fatty tissue. | |
| Carbohydrates. Sugar, starch, etc. | Transformed into fat. | |
| Mineral matters (ash). Phosphates of lime, potash, soda, etc. | Aid in forming bone, assist in digestion, etc. | |

*The Fuel Value of Food.*—Heat and muscular power are forms of force or energy. The energy is developed as the food is consumed in the body. The unit commonly used in this measurement is the calorie, the amount of heat which would raise the temperature of a pound of water 4 deg. Fahrenheit.

Instead of this unit some unit of mechanical energy might be used—for

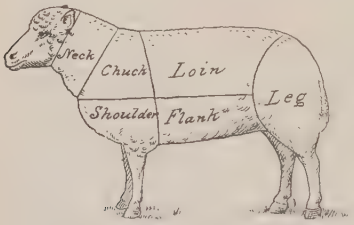


DIAGRAM OF CUTS OF MUTTON.

instance, the foot-ton, which represents the force required to raise one ton one foot. One calorie is equal to very nearly 1.53 foot-tons.

The following general estimate has been made for the average amount of potential energy in 1 pound of each of the classes of nutrients:

| | Calories. |
|---|---|
| In 1 pound of protein | 1,860 |
| In 1 pound of fats | 4,220 |
| In 1 pound of carbohydrates | 1,860 |

In other words, when we compare the nutrients in respect to their fuel values, their capacities for yielding heat and mechanical power,

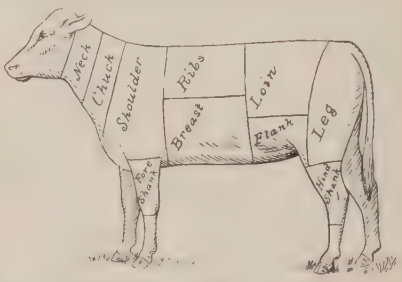


DIAGRAM OF CUTS OF VEAL.

a pound of protein of lean meat or albumen of egg is just about equivalent to a pound of sugar or starch, and a little over two pounds of either would

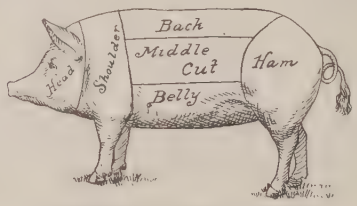


DIAGRAM OF CUTS OF PORK.

be required to equal a pound of the fat of meat or butter or the body fat.

Within recent years analyses of a large number of samples of foods have been made in this country. In the tables on pages 364-367 the results of a number of these analyses are given:

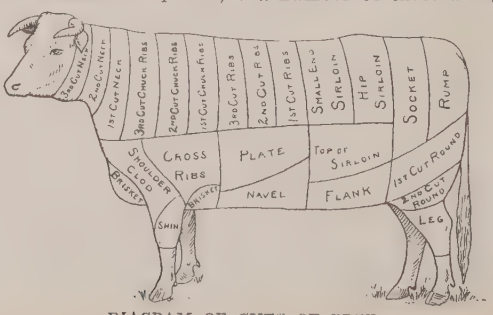


DIAGRAM OF CUTS OF BEEF.

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COMPARISON OF FARM ANIMALS IN THE UNITED STATES.

AVERAGE COMPOSITION OF AMERICAN FOOD PRODUCTS.

| Food Materials (as purchased). | Refuse. | Water. | Protein. | Fat. | Carbohydrates. | Ash. | Fuel Value per Lb. |
|---|---|---|---|---|---|---|---|
| ANIMAL FOOD. | | | | | | | |
| Beef, fresh: | Per Ct. | Per Ct. | Per Ct. | Per Ct. | Per Ct. | Per Ct. | Calories. |
| Chuck, including shoulder | 17.3 | 54.0 | 15.8 | 12.5 | ..... | 0.7 | 820 |
| Chuck ribs | 19.1 | 53.8 | 15.3 | 11.1 | ..... | .8 | 755 |
| Flank | 5.5 | 55.1 | 18.6 | 19.9 | ..... | .8 | 1,185 |
| Loin | 13.3 | 52.9 | 16.4 | 16.9 | ..... | .9 | 1,020 |
| Porterhouse steak | 12.7 | 52.4 | 19.1 | 17.9 | ..... | .8 | 1,110 |
| Sirloin steak | 12.8 | 54.0 | 16.5 | 16.1 | ..... | .9 | 985 |
| Neck | 31.2 | 45.3 | 14.2 | 9.2 | ..... | .7 | 650 |
| Ribs | 20.1 | 45.3 | 14.4 | 20.0 | ..... | .7 | 1,110 |
| Rib rolls | ..... | 64.8 | 19.4 | 15.5 | ..... | .9 | 1,015 |
| Round | 8.5 | 62.5 | 19.2 | 9.2 | ..... | 1.0 | 745 |
| Rump | 19.0 | 46.9 | 15.2 | 18.6 | ..... | .8 | 1,065 |
| Shank, fore | 38.3 | 43.2 | 13.2 | 5.2 | ..... | .6 | 465 |
| Shoulder and clod | 17.4 | 57.0 | 16.5 | 8.4 | ..... | .9 | 660 |
| Fore quarter | 20.6 | 43.5 | 14.4 | 15.1 | ..... | .7 | 905 |
| Hind quarter | 16.3 | 52.0 | 16.1 | 15.4 | ..... | .8 | 950 |
| Beef, corned, canned, pickled, and dried: | | | | | | | |
| Corned beef | 8.4 | 49.2 | 14.3 | 23.8 | ..... | 4.6 | 1,271 |
| Tongue, pickled | 6.0 | 53.9 | 11.9 | 19.2 | ..... | 4.3 | 1,030 |
| Dried, salted, and smoked | 4.7 | 53.7 | 26.4 | 6.9 | ..... | 8.9 | 780 |
| Canned boiled beef | ..... | 51.8 | 25.5 | 22.5 | ..... | 1.3 | 1,425 |
| Canned corned beef | ..... | 51.8 | 26.3 | 18.7 | ..... | 4.0 | 1,280 |
| Veal: | | | | | | | |
| Breast | 23.3 | 52.5 | 15.7 | 8.2 | ..... | .8 | 635 |
| Leg | 11.7 | 63.4 | 18.3 | 5.8 | ..... | 1.0 | 585 |
| Leg cutlets | 3.4 | 63.3 | 20.1 | 7.5 | ..... | 1.0 | 690 |
| Fore quarter | 24.5 | 54.2 | 15.1 | 6.0 | ..... | .7 | 535 |
| Hind quarter | 20.7 | 56.2 | 16.2 | 6.6 | ..... | .8 | 580 |
| Mutton: | | | | | | | |
| Flank | 9.9 | 39.0 | 13.8 | 36.9 | ..... | .6 | 1,815 |
| Leg, hind | 17.7 | 51.9 | 15.4 | 14.5 | ..... | .8 | 900 |
| Shoulder | 22.1 | 46.8 | 13.7 | 17.1 | ..... | .7 | 975 |
| Fore quarter | 21.2 | 41.6 | 12.3 | 24.5 | ..... | .7 | 1,265 |
| Hind quarter, without tallow | 19.3 | 43.3 | 13.0 | 24.0 | ..... | .7 | 1,255 |
| Lamb: | | | | | | | |
| Breast | 19.1 | 45.5 | 15.4 | 19.1 | ..... | .8 | 1,090 |
| Leg, hind | 13.8 | 50.3 | 16.0 | 19.7 | ..... | .9 | 1,130 |
| Pork, fresh: | | | | | | | |
| Flank | 18.0 | 48.5 | 15.1 | 18.6 | ..... | .7 | 1,065 |
| Ham | 10.3 | 45.1 | 14.3 | 29.7 | ..... | .8 | 1,520 |
| Loin chops | 19.3 | 40.8 | 13.2 | 26.0 | ..... | .8 | 1,340 |
| Shoulder | 12.4 | 44.9 | 12.0 | 29.8 | ..... | .7 | 1,480 |
| Tenderloin | ..... | 66.5 | 18.9 | 13.0 | ..... | 1.0 | 900 |
| Pork, salted, cured, and pickled: | | | | | | | |
| Ham, smoked | 12.2 | 35.8 | 14.5 | 33.2 | ..... | 4.2 | 1,670 |
| Shoulder, smoked | 18.9 | 30.7 | 12.6 | 33.0 | ..... | 5.0 | 1,625 |
| Salt pork | ..... | 7.9 | 1.9 | 86.2 | ..... | 3.9 | 3,670 |
| Bacon, smoked | 8.7 | 18.4 | 9.5 | 59.4 | ..... | 4.5 | 2,685 |
| Sausage: | | | | | | | |
| Bologna | 3.3 | 55.2 | 18.2 | 19.7 | ..... | 3.8 | 1,170 |
| Farmer | 3.9 | 22.2 | 27.9 | 40.4 | ..... | 7.3 | 2,225 |
| Frankfort | ..... | 57.2 | 19.6 | 18.6 | 1.1 | 3.4 | 1,170 |
| Soups: | | | | | | | |
| Celery, cream of | ..... | 88.6 | 2.1 | 2.8 | 5.0 | 1.5 | 250 |
| Beef | ..... | 92.9 | 4.4 | .4 | 1.1 | 1.2 | 120 |
| Meat stew | ..... | 84.5 | 4.6 | 4.3 | 5.5 | 1.1 | 370 |
| Tomato | ..... | 90.0 | 1.8 | 1.1 | 5.6 | 1.5 | 185 |
| Poultry: | | | | | | | |
| Chicken, broilers | 41.6 | 43.7 | 12.8 | 1.4 | ..... | .7 | 295 |
| Fowls | 25.9 | 47.1 | 13.7 | 12.3 | ..... | .7 | 775 |
| Goose | 17.6 | 38.5 | 13.4 | 29.8 | ..... | .7 | 1,505 |
| Turkey | 22.7 | 42.4 | 16.1 | 18.4 | ..... | .8 | 1,075 |
| Fish: | | | | | | | |
| Cod, dressed | 29.9 | 58.5 | 11.1 | .2 | ..... | .8 | 215 |
| Halibut, steaks or sections | 17.7 | 61.9 | 15.3 | 4.4 | ..... | .9 | 470 |
| Mackerel, whole | 44.7 | 40.4 | 10.2 | 4.2 | ..... | .7 | 365 |
| Perch, yellow, dressed | 35.1 | 50.7 | 12.8 | .7 | ..... | .9 | 265 |
| Shad, whole | 50.1 | 35.2 | 9.4 | 4.8 | ..... | .7 | 380 |
| Shad, roe | ..... | 71.2 | 20.9 | 3.8 | 2.6 | 1.5 | 600 |
| Fish, salt: Cod | 24.9 | 40.2 | 19.0 | .4 | ..... | 18.5 | 315 |

AVERAGE COMPOSITION OF AMERICAN FOOD PRODUCTS—*Continued.*

| Food Materials (as purchased). | Refuse. | Water. | Protein. | Fat. | Carbohydrates. | Ash. | Fuel Value per Lb. |
|---|---|---|---|---|---|---|---|
| | Per Ct. | Per Ct. | Per Ct. | Per Ct. | Per Ct. | Per Ct. | Calories. |
| Fish, canned: | | | | | | | |
| Salmon | 14.2 | 56.8 | 19.5 | 7.5 | ..... | 2.0 | 680 |
| Sardines | [1] 5.0 | 53.6 | 23.7 | 12.1 | ..... | 5.3 | 950 |
| Shellfish: | | | | | | | |
| Oysters, "solids" | ..... | 88.3 | 6.0 | 1.3 | 3.3 | 1.1 | 230 |
| Clams | ..... | 80.8 | 10.6 | 1.1 | 5.2 | 2.3 | 340 |
| Crabs | 52.4 | 36.7 | 7.9 | .9 | .6 | 1.5 | 195 |
| Lobsters | 61.7 | 30.7 | 5.9 | .7 | .2 | .8 | 140 |
| Eggs: Hens' eggs | [2] 11.2 | 65.5 | 11.9 | 9.3 | ..... | .9 | 635 |
| Dairy products, etc.: | | | | | | | |
| Butter | ..... | 11.0 | 1.0 | 85.0 | ..... | 3.0 | 3,605 |
| Whole milk | ..... | 87.0 | 3.3 | 4.0 | 5.0 | .7 | 325 |
| Skim milk | ..... | 90.5 | 3.4 | .3 | 5.1 | .7 | 170 |
| Buttermilk | ..... | 91.0 | 3.0 | .5 | 4.8 | .7 | 165 |
| Condensed milk | ..... | 26.9 | 8.8 | 8.3 | 54.1 | 1.9 | 1,520 |
| Cream | ..... | 74.0 | 2.5 | 18.5 | 4.5 | .5 | 910 |
| Cheese, Cheddar | ..... | 27.4 | 27.7 | 36.8 | 4.1 | 4.0 | 2,145 |
| Cheese, full cream | ..... | 34.2 | 25.9 | 33.7 | 2.4 | 3.8 | 1,950 |
| VEGETABLE FOOD. | | | | | | | |
| Flour, meal, etc.: | | | | | | | |
| Entire-wheat flour | ..... | 11.4 | 13.8 | 1.9 | 71.9 | 1.0 | 1,675 |
| Graham flour | ..... | 11.3 | 13.3 | 2.2 | 71.4 | 1.8 | 1,670 |
| Wheat flour, patent roller process— | | | | | | | |
| High-grade and medium | ..... | 12.0 | 11.4 | 1.0 | 75.1 | .5 | 1,650 |
| Low grade | ..... | 12.0 | 14.0 | 1.9 | 71.2 | .9 | 1,665 |
| Macaroni | ..... | 78.4 | 3.0 | 1.5 | 15.8 | 1.3 | 415 |
| Crushed wheat | ..... | 10.1 | 11.1 | 1.7 | 75.5 | 1.6 | 1,685 |
| Buckwheat flour | ..... | 13.6 | 6.4 | 1.2 | 77.9 | .9 | 1,620 |
| Corn meal | ..... | 12.5 | 9.2 | 1.9 | 75.4 | 1.0 | 1,655 |
| Oatmeal | ..... | 7.3 | 16.1 | 7.2 | 67.5 | 1.9 | 1,860 |
| Rice | ..... | 12.3 | 8.0 | .3 | 79.0 | .4 | 1,630 |
| Tapioca | ..... | 11.4 | .4 | .1 | 88.0 | .1 | 1,650 |
| Starch | ..... | ..... | ..... | ..... | 90.0 | ..... | 1,675 |
| Bread, pastry, etc.: | | | | | | | |
| White bread | ..... | 35.3 | 9.2 | 1.3 | 53.1 | 1.1 | 1,215 |
| Brown bread | ..... | 43.6 | 5.4 | 1.8 | 47.1 | 2.1 | 1,050 |
| Graham bread | ..... | 35.7 | 8.9 | 1.8 | 52.1 | 1.5 | 1,210 |
| Whole-wheat bread | ..... | 38.4 | 9.7 | .9 | 49.7 | 1.3 | 1,140 |
| Rye bread | ..... | 35.7 | 9.0 | .6 | 53.2 | 1.5 | 1,180 |
| Cake | ..... | 19.9 | 6.3 | 9.0 | 63.3 | 1.5 | 1,675 |
| Cream crackers | ..... | 6.8 | 9.7 | 12.1 | 69.7 | 1.7 | 1,990 |
| Oyster crackers | ..... | 4.8 | 11.3 | 10.5 | 70.5 | 2.9 | 1,965 |
| Soda crackers | ..... | 5.9 | 9.8 | 9.1 | 73.1 | 2.1 | 1,925 |
| Sugars, etc.: | | | | | | | |
| Molasses | ..... | 25.1 | 2.4 | ..... | 69.3 | 3.2 | 1,290 |
| Candy | ..... | ..... | ..... | ..... | 96.0 | ..... | 1,785 |
| Honey [3] | ..... | 18.2 | .4 | ..... | 81.2 | .2 | 1,520 |
| Sugar, granulated | ..... | ..... | ..... | ..... | 100.0 | ..... | 1,800 |
| Maple sirup | ..... | ..... | ..... | ..... | 71.4 | ..... | 1,330 |
| Vegetables: [4] | | | | | | | |
| Beans, dried | ..... | 12.6 | 22.5 | 1.8 | 59.6 | 3.5 | 1,605 |
| Beans, Lima, shelled | ..... | 68.5 | 7.1 | .7 | 22.0 | 1.7 | 570 |
| Beans, string | 7.0 | 83.0 | 2.1 | .3 | 6.9 | .7 | 180 |
| Beets | 20.0 | 70.0 | 1.3 | .1 | 7.7 | .9 | 170 |
| Cabbage | 15.0 | 77.7 | 1.4 | .2 | 4.8 | .9 | 125 |
| Celery | 20.0 | 75.6 | .9 | .1 | 2.6 | .8 | 70 |
| Corn, green (sweet), edible portion | ..... | 75.4 | 3.1 | 1.1 | 19.7 | .7 | 470 |
| Cucumbers | 15.0 | 81.1 | .7 | .2 | 2.6 | .4 | 70 |
| Lettuce | 15.0 | 80.5 | 1.0 | .2 | 2.5 | .8 | 75 |
| Mushrooms | ..... | 88.1 | 3.5 | .4 | 6.8 | 1.2 | 210 |
| Onions | 10.0 | 78.9 | 1.4 | .3 | 8.9 | .5 | 205 |
| Parsnips | 20.0 | 66.4 | 1.3 | .4 | 10.8 | 1.1 | 240 |
| Peas (*Pisum sativum*), dried | ..... | 9.5 | 24.6 | 1.0 | 62.0 | 2.9 | 1,655 |

[1] Refuse, oil. [2] Refuse, shell.

[3] Contained on an average cane sugar 2.8 and reducing sugar 71.1 per cent. The reducing sugar was composed of about equal amounts of glucose (dextrose) and fruit sugar (levulose).

[4] Such vegetables as potatoes, squash, beets, etc., have a certain amount of inedible material, skin, seeds, etc. The amount varies with the method of preparing the vegetables, and cannot be accurately estimated. The figures given for refuse of vegetables, fruits, etc., are assumed to represent approximately the amount of refuse in these foods as ordinarily prepared.

AVERAGE COMPOSITION OF AMERICAN FOOD PRODUCTS—*Continued.*

| Food Materials (as purchased). | Refuse. | Water. | Protein. | Fat. | Carbohydrates. | Ash. | Fuel Value per Lb. |
|---|---|---|---|---|---|---|---|
| | Per Ct. | Per Ct. | Per Ct. | Per Ct. | Per Ct. | Per Ct. | Calories. |
| Vegetables—(*Continued*): | | | | | | | |
| Peas (*Pisum sativum*), shelled | ..... | 74.6 | 7.0 | 0.5 | 16.9 | 1.0 | 465 |
| Cowpeas, dried | ..... | 13.0 | 21.4 | 1.4 | 60.8 | 3.4 | 1,590 |
| Potatoes | 20.0 | 62.6 | 1.8 | .1 | 14.7 | .8 | 310 |
| Rhubarb | 40.0 | 56.6 | .4 | .4 | 2.2 | .4 | 65 |
| Sweet potatoes | 20.0 | 55.2 | 1.4 | .6 | 21.9 | .9 | 640 |
| Spinach | ..... | 92.3 | 2.1 | .3 | 3.2 | 2.1 | 110 |
| Squash | 50.0 | 44.2 | .7 | .2 | 4.5 | .4 | 105 |
| Tomatoes | ..... | 94.3 | .9 | .4 | 3.9 | .5 | 105 |
| Turnips | 30.0 | 62.7 | .9 | .1 | 5.7 | .6 | 125 |
| Vegetables, canned: | | | | | | | |
| Peas (*Pisum sativum*), green | ..... | 85.3 | 3.6 | .2 | 9.8 | 1.1 | 255 |
| Corn, green | ..... | 76.1 | 2.8 | 1.2 | 19.0 | .9 | 455 |
| Tomatoes | ..... | 94.0 | 1.2 | .2 | 4.0 | .6 | 105 |
| Fruits, berries, etc., fresh:[1] | | | | | | | |
| Apples | 25.0 | 63.3 | .3 | .3 | 10.8 | .3 | 220 |
| Bananas | 35.0 | 48.9 | .8 | .4 | 14.3 | .6 | 300 |
| Grapes | 25.0 | 58.0 | 1.0 | 1.2 | 14.4 | .4 | 335 |
| Lemons | 30.0 | 62.5 | .7 | .5 | 5.9 | .4 | 145 |
| Muskmelons | 50.0 | 44.8 | .3 | ..... | 4.6 | .3 | 90 |
| Oranges | 27.0 | 63.4 | .6 | .1 | 8.5 | .4 | 170 |
| Pears | 10.0 | 76.0 | .5 | .4 | 12.7 | .4 | 260 |
| Persimmons, edible portion | ..... | 66.1 | .8 | .7 | 31.5 | .9 | 630 |
| Raspberries | ..... | 85.8 | 1.0 | ..... | 12.6 | .6 | 255 |
| Strawberries | 5.0 | 85.9 | .9 | .6 | 7.0 | .6 | 175 |
| Watermelons | 59.4 | 37.5 | .2 | .1 | 2.7 | .1 | 60 |
| Fruits, dried: | | | | | | | |
| Apples | ..... | 28.1 | 1.6 | 2.2 | 66.1 | 2.0 | 1,350 |
| Apricots | ..... | 81.4 | .9 | ..... | 17.3 | .4 | 340 |
| Dates | 10.0 | 13.8 | 1.9 | 2.5 | 70.6 | 1.2 | 1,450 |
| Figs | ..... | 18.8 | 4.3 | .3 | 74.2 | 2.4 | 1,475 |
| Nuts: | | | | | | | |
| Almonds | 45.0 | 2.7 | 11.5 | 30.2 | 9.5 | 1.1 | 1,660 |
| Beechnuts | 40.8 | 2.3 | 13.0 | 34.0 | 7.8 | 2.1 | 1,820 |
| Brazil nuts | 49.6 | 2.6 | 8.6 | 33.7 | 3.5 | 2.0 | 1,655 |
| Butternuts | 86.4 | .6 | 3.8 | 8.3 | .5 | .4 | 430 |
| Chestnuts, fresh | 16.0 | 37.8 | 5.2 | 4.5 | 35.4 | 1.1 | 945 |
| Chestnuts, dried | 24.0 | 4.5 | 8.1 | 5.3 | 56.4 | 1.7 | 1,425 |
| Cocoanuts | [2] 48.8 | 7.2 | 2.9 | 25.9 | 14.3 | .9 | 1,413 |
| Cocoanut, prepared | ..... | 3.5 | 6.3 | 57.4 | 31.5 | 1.3 | 3,125 |
| Filberts | 52.1 | 1.8 | 7.5 | 31.3 | 6.2 | 1.1 | 1,575 |
| Hickory nuts | 62.2 | 1.4 | 5.8 | 25.5 | 4.3 | .8 | 1,265 |
| Pecans, polished | 53.2 | 1.4 | 5.2 | 33.3 | 6.2 | .7 | 1,620 |
| Peanuts | 24.5 | 6.9 | 19.5 | 29.1 | 18.5 | 1.5 | 1,935 |
| Piñon (*Pinus edulis*) | 40.6 | 2.0 | 8.7 | 36.8 | 10.2 | 1.7 | 1,905 |
| Walnuts, California, black | 74.1 | .6 | 7.2 | 14.6 | 3.0 | .5 | 805 |
| Walnuts, California, soft-shell | 58.1 | 1.0 | 6.9 | 26.6 | 6.8 | .6 | 1,375 |
| Raisins | 10.0 | 13.1 | 2.3 | 3.0 | 68.5 | 3.1 | 1,455 |
| Miscellaneous: | | | | | | | |
| Chocolate | ..... | 5.9 | 12.9 | 48.7 | 30.3 | 2.2 | 2,860 |
| Cocoa, powdered | ..... | 4.6 | 21.6 | 28.9 | 37.7 | 7.2 | 2,320 |
| Cereal coffee, infusion (1 part boiled in 20 parts water)[3] | ..... | 98.2 | .2 | ..... | 1.4 | .2 | 30 |

[1] Fruits contain a certain proportion of inedible materials, as skin, seeds, etc., which are properly classed as refuse. In some fruits, as oranges and prunes, the amount rejected in eating is practically the same as refuse. In others, as apples and pears, more or less of the edible material is ordinarily rejected with the skin and seeds and other inedible portions. The edible material which is thus thrown away, and should properly be classed with the waste, is here classed with the refuse. The figures for refuse here given represent, as nearly as can be ascertained, the quantities ordinarily rejected.

[2] Milk and shell.

[3] The average of five analyses of cereal coffee grain is: Water 6.2, protein 13.3, fat 3.4, carbohydrates 72.6, and ash 4.5 per cent. Only a portion of the nutrients, however, enter into the infusion. The average in the table represents the available nutrients in the beverage. Infusions of genuine coffee and of tea like the above contain practically no nutrients.

## DIETARY STANDARDS.

Dietary studies have been made in considerable numbers in different countries. The results of such studies and experiments to determine the amount of food required by men engaged in different occupations have resulted in the adoption of dietary standards. Some of these follow:

STANDARDS FOR DAILY DIETARIES.

| Character of Work to be Performed. | Nutrients. | | | Fuel. Value. |
|---|---|---|---|---|
| | Protein. | Fat. | Carbohydrates. | |
| European: | Pound. | Pound. | Pounds. | Calories. |
| Man at moderate work | 0.26 | 0.12 | 1.10 | 3,055 |
| Man at hard work | .32 | .22 | .99 | 3,370 |
| American: | | | | |
| Man without muscular work | .20 | | | 3,000 |
| Man with light muscular work | .22 | | | 3,000 |
| Man with moderate muscular work | .28 | | | 3,500 |
| Man with hard muscular work | .39 | | | 4,500 |

The table of composition of food materials shows the amount of water, protein, fat, carbohydrates and ash content and the total fuel value per pound for each kind of food named. The protein, fat and carbohydrates all furnish energy. In addition to furnishing energy, protein forms tissue. Since protein and energy are the essential features of food, dietary standards may be expressed in their simplest form in terms of protein and energy alone.

Observation has shown that as a rule a woman requires less food than a man, and the amount required by children is still less, varying with the age. It is customary to assign certain factors which shall represent the amount of nutrients required by children of different ages and by women as compared with adult man. The various factors which have been adopted are as follows:

### FACTORS USED IN CALCULATING MEALS CONSUMED IN DIETARY STUDIES.

One meal of woman equivalent to 0.8 meal of man at moderate muscular labor.

One meal of boy 14 to 16 years of age, inclusive, equivalent to 0.8 meal of man.

One meal of girl 14 to 16 years of age, inclusive, equivalent to 0.7 meal of man.

One meal of child 10 to 13 years of age, inclusive, equivalent to 0.6 meal of man.

One meal of child 6 to 9 years of age, inclusive, equivalent to 0.5 meal of man.

One meal of child 2 to 5 years of age, inclusive, equivalent to 0.4 meal of man.

One meal of child under 2 years of age equivalent to 0.3 meal of man.

These factors are based in part upon experimental data and in part upon arbitrary assumptions. They are subject to revision when experimental evidence shall warrant more definite conclusions.

The plan followed in making dietary studies is, briefly, as follows: Exact account is taken of all the food materials (1) at the beginning of the study, (2) purchased during its progress, and (3) remaining at the end. The difference between the third and the sum of the first and second is taken as representing the amount used. From the figures thus obtained for the total quantities of the different food materials the amounts of the different nutrients and the energy furnished by them are calculated. Deducting from these values the nutrients and energy found in the kitchen and table refuse, the amounts actually consumed are obtained. Account is also taken of the meals eaten by different members of the family or groups studied and by visitors, if there are any. From the total food eaten by all the persons during the entire period the amount eaten per man per day may be calculated. In making these calculations due account is taken of the fact that, as stated above, women and children eat less than men performing the same amount of work.

# PRODUCTS OF THE FISHERIES OF THE UNITED STATES.

Specially prepared for the Scientific American Reference Book by the United States Fish Commission.

| Species. | New England States, 1902. | | Middle Atlantic States, 1901. | | South Atlantic States, 1902. | | Gulf States, 1902. | | Pacific Coast States, 1899. | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Pounds. | Value. | Pounds. | Value. | Pounds. | Value. | Pounds. | Value. | Pounds. | Value. |
| Alewives | 8,437,296 | $89,283 | 34,479,005 | $262,352 | 11,601,172 | $118,258 | | | | |
| Barracuda | | | | | 1,000 | 50 | 34,435 | $1,203 | 1,191,505 | $32,703 |
| Black bass | | | 233,378 | 19,780 | 948,235 | 70,524 | 84,730 | 5,865 | | |
| Bluefish | 689,760 | 42,991 | 16,317,795 | 758,122 | 1,057,642 | 37,856 | 398,776 | 12,435 | | |
| Bonito | 291,650 | 9,774 | 1,668,555 | 42,695 | 10,326 | 244 | 10,100 | 503 | 119,737 | 3,893 |
| Buffalo-fish | | | | | | | 3,006,610 | 26,556 | | |
| Butter-fish | 543,958 | 17,489 | 5,129,543 | 149,984 | 83,218 | 1,357 | 3,140 | 46 | | |
| Catfish | 489,968 | 4,355 | 2,063,584 | 77,396 | 1,310,392 | 30,976 | 2,415,315 | 72,991 | 625,971 | 15,935 |
| Cod | 87,628,949 | 2,176,787 | 3,475,012 | 119,590 | | | | | 6,847,131 | 201,304 |
| Crappie and strawberry bass | | | | | 223,606 | 5,226 | 29,900 | 1,928 | | |
| Croakers | | | 4,501,894 | 64,201 | 1,991,053 | 40,021 | 543,810 | 19,326 | 40,919 | 1,123 |
| Cusk | 5,405,824 | 79,418 | | | | | | | | |
| Drum, fresh-water | | | | | | | 5,550 | 131 | | |
| Drum, salt-water | | | 343,152 | 4,201 | 583,394 | 14,453 | 3,026,756 | 90,260 | | |
| Eels | 1,402,558 | 75,111 | 2,900,927 | 152,874 | 512,411 | 20,068 | | | | |
| Flatfish and flounders | 4,535,746 | 130,057 | 3,231,039 | 111,755 | 315,642 | 6,783 | 438,741 | 17,959 | 4,726,827 | 92,646 |
| German carp | 2,134 | 164 | 1,159,958 | 59,238 | 96,509 | 3,616 | 1,175 | 33 | 283,514 | 2,400 |
| Haddock | 46,701,315 | 944,700 | 387,666 | 14,617 | | | | | | |
| Hake | 32,600,559 | 332,680 | 407,429 | 6,500 | | | | | | |
| Halibut | 12,360,705 | 662,538 | | | | | | | 6,877,640 | 192,580 |
| Herring | 189,916,967 | 905,460 | 180,000 | 2,025 | | | | | 2,080,137 | 20,850 |
| Mackerel | 20,358,982 | 1,136,754 | 519,643 | 21,211 | | | | | 153,666 | 6,415 |
| Menhaden | 18,469,390 | 56,401 | 493,936,462 | 987,228 | 18,862,000 | 31,420 | 12,500 | 50 | | |
| Mullet | | | 325,459 | 13,465 | 14,310,808 | 256,348 | 27,098,435 | 442,536 | 22,000 | 610 |
| Paddlefish | | | | | | | | | | |
| Perch, white | 82,335 | 4,740 | 2,752,649 | 154,239 | 945,050 | 62,786 | | | | |
| Perch, yellow | 450 | 30 | 495,346 | 17,203 | 105,992 | 5,639 | | | | |
| Pike perch | | | 14,675 | 2,321 | | | | | | |
| Pike and pickerel | 8,230 | 530 | 120,553 | 9,287 | 31,200 | 1,505 | 58,975 | 2,338 | 16,005 | 639 |
| Pollock | 17,702,127 | 169,199 | 42,581 | 1,240 | | | | | | |
| Pompano | | | 96,326 | 7,563 | 289,821 | 23,300 | 538,344 | 30,160 | 13,135 | 4,457 |
| Rockfish | | | | | | | | | 1,304,810 | 39,626 |
| Salmon | 60,226 | 13,291 | 1,793 | 353 | | | | | 130,004,835 | 3,504,622 |
| Scup | 7,818,530 | 189,429 | 1,466,931 | 43,350 | | | | | | |
| Sea-bass | 475,700 | 26,477 | 2,467,676 | 126,668 | 873,095 | 36,420 | 17,095 | 457 | 943,156 | 20,642 |
| Shad | 1,380,812 | 58,564 | 31,897,687 | 1,253,622 | 9,849,338 | 605,539 | 150 | 3 | 1,254,801 | 15,898 |
| Sheepshead | | | 17,165 | 1,317 | 635,830 | 18,285 | 1,974,815 | 48,590 | | |
| Smelt | 1,079,448 | 100,364 | | | | | | | 2,280,249 | 68,214 |
| Snappers, red | 68,750 | 2,750 | | | 155,100 | 8,203 | 13,608,553 | 410,157 | | |
| Snappers, other | | | | | 42,543 | 977 | 358,806 | 10,442 | | |

PRODUCTS OF THE FISHERIES OF THE UNITED STATES.—*Continued.*

| Species. | New England States, 1902. | | Middle Atlantic States, 1901. | | South Atlantic States, 1902. | | Gulf States, 1902. | | Pacific Coast States, 1899. | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Pounds. | Value. | Pounds. | Value. | Pounds. | Value. | Pounds. | Value. | Pounds. | Value. |
| Spanish mackerel | 410 | $64 | 566,096 | $51,027 | 1,013,172 | $54,322 | 1,583,891 | $64,458 | ..... | ..... |
| Spot | ..... | ..... | 1,133,189 | 28,370 | 926,946 | 21,425 | 155,600 | 3,356 | ..... | ..... |
| Squeteague | 7,336,052 | 177,622 | 23,496,383 | 558,653 | 4,848,269 | 190,380 | 4,789,047 | 173,207 | ..... | ..... |
| Striped bass | 135,633 | 13,662 | 1,838,919 | 178,848 | 1,187,700 | 114,574 | ..... | ..... | 1,234,320 | $61,814 |
| Sturgeon | 17,980 | 1,349 | 648,610 | 33,886 | 218,075 | 11,209 | 467,391 | 13,662 | 295,344 | 15,333 |
| Sturgeon, shovel-nose | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| Suckers | 126,307 | 4,651 | 424,059 | 19,104 | 169,350 | 4,899 | 4,800 | 372 | ..... | ..... |
| Sunfish | 9,020 | 380 | 25,015 | 1,585 | 660,514 | 14,685 | 44,050 | 2,134 | ..... | ..... |
| Swordfish | 1,689,740 | 118,320 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| Tautog | 605,570 | 20,253 | 144,367 | 5,114 | 2,650 | 53 | ..... | ..... | ..... | ..... |
| Whitefish | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | 58,010 | 1,169 |
| Other fish | 3,449,138 | 29,210 | 2,825,386 | 60,620 | 2,434,909 | 98,451 | 3,545,566 | 95,837 | 4,749,054 | 79,635 |
| Caviar | 455 | 281 | 57,842 | 33,630 | 20,780 | 13,284 | 11,105 | 5,336 | ..... | ..... |
| Crabs | 15,786 | 2,160 | 23,650,655 | 495,385 | 385,707 | 18,950 | 1,708,625 | 29,741 | 4,061,980 | 99,518 |
| Lobsters | 14,028,845 | 1,271,962 | 252,242 | 30,376 | ..... | ..... | ..... | ..... | ..... | ..... |
| Spiny lobsters | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | 606,713 | 14,198 |
| Crawfish | ..... | ..... | ..... | ..... | ..... | ..... | 71,664 | 3,897 | 116,400 | 7,760 |
| Shrimp and prawn | 7,200 | 1,740 | 7,673 | 2,838 | 3,810,641 | 86,640 | 12,366,915 | 198,979 | 1,621,600 | 107,957 |
| Squid | 5,496,461 | 28,409 | 198,594 | 5,940 | ..... | ..... | ..... | ..... | 622,740 | 18,682 |
| Clams | 8,993,430 | 586,535 | 9,300,474 | 1,075,264 | 1,415,440 | 100,752 | 800 | 100 | 6,281,549 | 63,727 |
| Oysters | 19,550,643 | 2,193,316 | 138,247,739 | 10,287,556 | 22,719,074 | 644,478 | 34,115,935 | 1,263,689 | 34,760,420 | 1,043,192 |
| Scallops | 632,728 | 130,674 | 1,223,724 | 110,537 | 13,020 | 980 | ..... | ..... | 3,939 | 738 |
| Abalone and mussels | ..... | ..... | 637,000 | 2,780 | ..... | ..... | ..... | ..... | 752,687 | 26,690 |
| Terrapin and turtle | ..... | ..... | 158,219 | 12,564 | 120,524 | 30,587 | 563,956 | 50,060 | 107,869 | 10,376 |
| Frogs | ..... | ..... | 16,307 | 1,573 | 5,990 | 599 | ..... | ..... | 20,687 | 20,638 |
| Sponges | ..... | ..... | ..... | ..... | ..... | ..... | 346,889 | 364,422 | ..... | ..... |
| Oil, fish | 185,703 | 8,039 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| Oil, whale | 5,136,767 | 292,875 | ..... | ..... | ..... | ..... | ..... | ..... | 522,300 | 20,491 |
| Whalebone | 19,000 | 90,000 | ..... | ..... | ..... | ..... | ..... | ..... | 207,392 | 436,272 |
| Fur-seal pelts | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | 375 | 1,000 |
| Alligator hides | ..... | ..... | ..... | ..... | 100,687 | 13,538 | 249,240 | 27,241 | ..... | ..... |
| Otter skins | ..... | ..... | ..... | ..... | 2,927 | 17,352 | 356 | 1,015 | ..... | ..... |
| Oyster shells | ..... | ..... | 2,430,000 | 1,362 | ..... | ..... | ..... | ..... | ..... | ..... |
| Mussel shells | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| Other products | 2,994,560 | 79,563 | 1,130,200 | 4,091 | 1,554,320 | 2,621 | 4,429 | 2,721 | 3,155,739 | 24,892 |
| Total | 528,943,797 | 12,280,401 | 819,046,576 | 17,485,500 | 106,446,072 | 2,839,633 | 113,696,970 | 3,494,196 | 217,965,156 | 6,278,639 |

PRODUCTS OF THE FISHERIES OF THE UNITED STATES.—*Continued.*

| Species. | Mississippi River and Tributaries, 1899. | | Great Lakes, 1899. | | Minor Interior Waters, chiefly for 1900 and 1902. | | Alaska, 1903. | | Total. | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Pounds. | Value. | Pounds. | Value. | Pounds. | Value. | Pounds. | Value. | Pounds. | Value. |
| Alewives | | | | | | | | | 54,517,473 | $469,893 |
| Barracuda | | | | | | | | | 1,226,940 | 33,956 |
| Black bass | 948,184 | $56,652 | 196,216 | $14,053 | 175,029 | $18,025 | | | 2,585,772 | 184,899 |
| Bluefish | | | | | | | | | 18,463,973 | 851,404 |
| Bonito | | | | | 34,308 | 1,549 | | | 2,134,676 | 58,658 |
| Buffalo-fish | 14,215,975 | 349,913 | | | | | | | 17,222,585 | 376,469 |
| Butter-fish | | | | | | | | | 5,759,859 | 168,876 |
| Catfish | 7,648,179 | 339,800 | 2,182,800 | 68,527 | 677,207 | 32,883 | | | 17,413,416 | 642,863 |
| Cod | | | | | | | | | 97,951,092 | 2,497,681 |
| Crappie and strawberry bass | 1,318,832 | 61,400 | 60,000 | 1,800 | 25,030 | 810 | | | 1,657,368 | 71,164 |
| Croakers | | | | | | | | | 7,077,676 | 124,671 |
| Cusk | | | | | | | | | 5,405,824 | 79,418 |
| Drum, fresh-water | 3,149,232 | 108,786 | 1,380,190 | 9,513 | 12,567 | 899 | | | 4,547,539 | 119,329 |
| Drum, salt-water | | | | | | | | | 3,953,302 | 108,914 |
| Eels | 93,905 | 4,803 | 126,034 | 6,313 | 29,209 | 2,046 | | | 5,065,044 | 261,215 |
| Flatfish and flounders | | | | | | | | | 13,247,995 | 359,200 |
| German carp | 11,868,840 | 289,258 | 3,674,346 | 52,362 | 1,016,129 | 12,029 | | | 18,102,605 | 419,100 |
| Haddock | | | | | | | | | 47,088,981 | 959,317 |
| Hake | | | | | | | | | 33,007,988 | 339,180 |
| Halibut | | | | | | | | | 19,238,345 | 855,118 |
| Herring | | | | | | | 116,000 | $4,060 | 192,293,104 | 932,395 |
| Herring, lake | | | 59,913,576 | 941,067 | 20,360 | 618 | | | 59,933,936 | 941,685 |
| Mackerel | | | | | | | | | 21,032,291 | 1,164,380 |
| Menhaden | | | | | | | | | 531,280,352 | 1,075,099 |
| Mullet | | | | | | | | | 41,756,702 | 712,959 |
| Paddle-fish | 2,473,250 | 55,514 | | | | | | | 2,473,250 | 55,514 |
| Perch, white | | | | | | | | | 3,780,034 | 221,765 |
| Perch, yellow | 65,006 | 2,666 | 9,584,802 | 156,350 | 217,715 | 15,332 | | | 10,469,311 | 197,220 |
| Pike perch | 249,435 | 13,955 | 11,070,239 | 380,556 | 371,453 | 26,371 | | | 11,705,802 | 423,203 |
| Pike and pickerel | 216,952 | 8,045 | 457,024 | 20,698 | 286,682 | 28,066 | | | 1,195,621 | 71,108 |
| Pollock | | | | | | | | | 17,744,708 | 170,439 |
| Pompano | | | | | | | | | 937,626 | 65,480 |
| Rockfish | | | | | | | | | 1,304,810 | 39,626 |
| Salmon | | | | | 125,858 | 5,629 | 162,491,230 | 10,021,617 | 292,683,942 | 13,545,512 |
| Scup | | | | | | | | | 9,285,461 | 232,779 |
| Sea-bass | | | | | | | | | 4,776,722 | 210,664 |
| Shad | 6,955 | 355 | | | | | | | 44,389,743 | 1,933,981 |
| Sheepshead | | | | | | | | | 2,627,810 | 68,192 |
| Smelt | | | | | 23,600 | 2,720 | | | 3,383,297 | 171,298 |
| Snappers, red | | | | | | | | | 13,832,403 | 421,110 |
| Snappers, other | | | | | | | | | 401,349 | 11,419 |

| Species. | Mississippi River and Tributaries 1899. | | Great Lakes, 1899. | | Minor Interior Waters, chiefly for 1900 and 1902. | | Alaska, 1903. | | Total. | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Pounds. | Value. | Pounds. | Value. | Pounds. | Value. | Pounds. | Value. | Pounds. | Value. |
| Spanish mackerel | | | | | | | | | 3,163,569 | $169,871 |
| Spot | | | | | | | | | 2,215,735 | 53,151 |
| Squeteague | | | | | | | | | 40,469,751 | 1,099,862 |
| Striped bass | | | | | | | | | 4,396,572 | 368,898 |
| Sturgeon | 234,145 | $8,064 | 1,129,348 | $81,085 | 198,182 | $7,539 | | | 3,209,075 | 172,127 |
| Sturgeon, shovel-nose | 711,693 | 19,142 | | | | | | | 711,693 | 19,142 |
| Suckers | 2,243,934 | 76,993 | 4,043,987 | 56,068 | 1,283,897 | 24,692 | | | 8,296,334 | 186,779 |
| Sunfish | 910,963 | 21,318 | 385,201 | 7,204 | 19,498 | 1,109 | | | 2,054,261 | 48,415 |
| Swordfish | | | | | | | | | 1,689,740 | 118,320 |
| Tautog | | | | | | | | | 752,587 | 25,420 |
| Trout, lake | | | 10,611,588 | 431,276 | 75,590 | 9,697 | | | 10,687,178 | 440,973 |
| Whitefish | | | 6,682,952 | 338,918 | 278,340 | 14,712 | | | 7,019,302 | 354,799 |
| Other fish | 1,293,618 | 29,497 | 2,015,133 | 38,829 | 899,271 | 222,038 | | | 21,212,075 | 654,117 |
| Caviar | 70,700 | 26,879 | | | 19,941 | 12,115 | | | 180,823 | 91,525 |
| Crabs | | | | | | | | | 29,822,753 | 645,754 |
| Lobsters | | | | | | | | | 14,281,087 | 1,302,338 |
| Spiny lobsters | | | | | | | | | 606,713 | 14,198 |
| Crawfish | | | 135,861 | 3,498 | | | | | 323,925 | 15,155 |
| Shrimp and prawn | 200,058 | 16,095 | | | | | | | 18,014,087 | 414,249 |
| Squid | | | | | | | | | 6,317,795 | 53,031 |
| Clams | | | | | | | | | [1] 25,991,693 | 1,826,378 |
| Oysters | | | | | | | | | [2] 249,393,811 | 15,432,231 |
| Scallops | | | | | | | | | [3] 1,873,411 | 242,929 |
| Abalone and mussels | | | | | | | | | 1,389,687 | 29,470 |
| Terrapin and turtle | 782,015 | 17,148 | 67,211 | 2,324 | 1,113 | 115 | | | 1,800,907 | 123,174 |
| Frogs | 440,996 | 53,054 | 10,732 | 998 | 23,300 | 1,796 | | | 518,012 | 78,658 |
| Sponges | | | | | | | | | 346,889 | 364,422 |
| Oil, fish | | | | | | | 1,096,875 | $34,410 | [4] 1,282,578 | 42,449 |
| Oil, whale | | | | | | | | | [5] 5,659,067 | 313,366 |
| Whalebone | | | | | | | | | 226,392 | 526,272 |
| Fur-seal pelts | | | | | | | 116,022 | 570,442 | [6] 116,397 | 571,442 |
| Alligator hides | 4,950 | 1,238 | | | | | | | [7] 354,877 | 42,017 |
| Otter skins | 1,620 | 4,050 | | | | | | | [8] 4,903 | 22,417 |
| Oyster shells | | | | | | | | | 2,430,000 | 1,362 |
| Mussel shells | 47,648,000 | 216,404 | | | | | | | 47,648,000 | 216,404 |
| Other products | | | | | | | 2,688,000 | 33,600 | 11,527,248 | 147,488 |
| Total | 96,797,437 | $1,781,029 | 113,727,240 | $2,611,439 | 5,814,279 | $440,790 | 166,508,127 | $10,664,129 | 2,168,945,654 | $57,875,756 |

NOTE.—In the above table the products of the fisheries are given in weight and value as they leave the hands of the fishermen, except that the value of salmon for Alaska is for the product after being canned or otherwise prepared for market, and the weight of clams, oysters, and other shell-fish is for the soft or edible part.

[1] 2,323,166 bushels.
[2] 31,181,253 bushels.
[3] 300,573 bushels.
[4] 171,010 gallons.
[5] 754,530 gallons.
[6] 19,462 in number.
[7] 71,360 in number.
[8] 3,308 in number.

## LEGAL WEIGHTS (IN POUNDS) PER BUSHEL.

| States and Territories. | Apples. | | | Beans. | | | | | | | | | | | Coal. | | | | | | | Corn. | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Apples.* | Dried Apples. | Barley. | Beans.* | Castor Beans (shelled). | Beets. | Blue-grass Seed. | Bran.* | Broom-corn Seed. | Buckwheat. | Carrots. | Charcoal. | Clover Seed. | Coal.* | Anthracite Coal. | Bituminous Coal. | Cannel Coal. | Mineral Coal. | Stone Coal. | Coke. | Corn.* | Corn in Ear, Husked. | Corn in Ear, Unhusked. | Shelled Corn. | Corn Meal.* |
| United States | | | 48 | | 50 | | | | | 42 | | | | | | 80 | | | | | 56 | | | | 48 |
| Alabama | | 24 | 47 | 60 | | | | | | | | | | | 80 | | | | | | | 70 | 75 | 56 | |
| Arizona | | | 45 | [1]55 | | | | | | | | | | | | | | | | | 54 | 70 | 74 | | |
| Arkansas | [2]50 | 24 | 48 | [1]60 | | | 14 | 20 | 48 | 52 | | | 60 | | | | | | | | | | | 56 | 48 |
| California | | | | | | | | | | | | | | | | | | | | | | | | | |
| Colorado | | | 48 | 60 | | | 14 | | | 52 | | | 60 | 80 | | | | 80 | | | | 70 | | | 50 |
| Connecticut | 48 | 25 | 48 | 60 | | [3]60 | | 20 | | 48 | 50 | 20 | 60 | | 80 | | | | | | | | | | |
| Delaware | | | | | | | | | | | | 20 | | | | | | | | | | | | | |
| Dist. of Columbia | | | | | | | | | | | | | | | | | | | | | | | 70 | 56 | 48 |
| Florida | [2]48 | 24 | 48 | [4]60 | 48 | | | 20 | | | | | | | | | | | | | | | | | |
| Georgia | | 24 | 47 | [5]60 | | | 14 | [6]20 | | 52 | | | 60 | | | | | | 80 | | | 70 | | 56 | 48 |
| Hawaii | | | 48 | | | | | | | | | | | | | | | | | | | | | | |
| Idaho | [2]45 | 28 | 48 | | | | | | | 42 | | | 60 | | | | | | | | | | | | |
| Illinois | | 24 | 48 | [5]60 | 46 | | 14 | 20 | | 52 | | | 60 | | | | | | 80 | | | 70 | | 56 | 48 |
| Indian Territory | | | | | | | | | | | | | | | | | | | | | [7]70 | | | | |
| Indiana | | 25 | 48 | 60 | 46 | | 14 | | | 50 | | | 60 | | | | | 80 | | | | | | 56 | 50 |
| Iowa | 48 | 24 | 48 | 60 | 46 | | 14 | 20 | 30 | 52 | | 20 | 60 | | | | | | 80 | 38 | | [8]70 | | 56 | |
| Kansas | [2]48 | 24 | 48 | 60 | 46 | | [9]14 | 20 | | 50 | | | 60 | | | | | | 80 | | | [10]70 | | | 50 |
| Kentucky | | 24 | 47 | [5]60 | *45 | | 14 | 20 | | 56 | | | 60 | 76 | 76 | 76 | 76 | 76 | 76 | | [11]70 | | | 56 | 50 |
| Louisiana | | | | | | | | | | | | | | | | | | | | | | | | | |
| Maine | 44 | | 48 | 62 | | 60 | | | | 48 | 50 | | | | | | | | | | 56 | | | | [12]50 |
| Maryland | | | | | | | | | | | | 20 | | | | | | | | | | | | | |
| Massachusetts | 48 | 25 | 48 | [13]60 | | | | 20 | | 48 | 50 | | 60 | | | | | | | | | | | [14]50 | 50 |
| Michigan | 48 | 22 | 48 | 60 | | | 14 | | | 48 | | | 60 | | | | | 80 | | | | [8]70 | | 56 | 50 |
| Minnesota | [2]50 | 28 | 48 | 60 | | 50 | 14 | | 57 | 50 | 45 | 20 | 60 | 80 | | | | | | | | 70 | | 56 | |

## LEGAL WEIGHTS (IN POUNDS) PER BUSHEL—*Continued.*

| | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Mississippi | | 26 | 48 | [5]60 | 46 | | 14 | 20 | | 48 | | | 60 | | | | | | 80 | | | 72 | | 56 | 48 |
| Missouri | 48 | 24 | 48 | [15]60 | 46 | | 14 | 20 | | 52 | 50 | | 60 | | | | | 80 | | | | 70 | 56 | 50 |
| Montana | 48 | | | 60 | | 50 | 14 | 20 | | 52 | 50 | | 60 | | | | | 76 | | | 70 | | 56 | 50 |
| Nebraska | | 24 | 48 | [5]60 | 46 | | 14 | 20 | | 52 | | | 60 | | | | | | 80 | | 70 | | 56 | 50 |
| Nevada | | | | | | | | | | | | | | | | | | | | | | | | | | |
| New Hampshire | | | | 62 | | | | | | | | | | | | | | | | | | | | | 50 |
| New Jersey | 50 | 25 | 48 | 60 | | | | | | 50 | | | 64 | | | | | | | 56 | | | | | 50 |
| New Mexico | | | | | | | | | | | | | | | | | | | | | | | | | | |
| New York | 48 | 25 | 48 | 60 | | | | 20 | | 48 | 50 | | 60 | | | | | | | | | | | | 50 |
| North Carolina | | | 48 | | | | | | | 50 | | | 60 | | | | | | | | | | | | |
| North Dakota | 50 | | 48 | 60 | | 60 | | 20 | 30 | 42 | | | 60 | | | | | | 80 | | 70 | | 56 | | |
| Ohio | 50 | 24 | 48 | 60 | | 56 | | | | 50 | 50 | | 60 | | | 80 | 70 | | | 40 | 68 | | 56 | | |
| Oklahoma | | | 48 | 60 | | 60 | | 20 | 30 | 42 | | | 60 | | | | | | 80 | | 70 | | 56 | | |
| Oregon | 45 | 28 | 46 | | | | | | | 42 | | | 60 | | | | | | | | | | | | |
| Pennsylvania | | | 47 | | | | | | | 48 | | [16]18[17] | 60 | [18]75 | | 76 | | | | 40 | | | | | |
| Rhode Island | 48 | 25 | 48 | 60 | 46 | 50 | | 20 | | 48 | 50 | 20 | 60 | 80 | | | | | | 40 | 70 | | 56 | 50 | |
| South Carolina | | | | | | | | | | | | | | | | | | | | | | | | [19]48 | |
| South Dakota | | | 48 | 60 | | 60 | | 20 | 30 | 42 | | | 60 | | | | | | 80 | | 70 | | 56 | | |
| Tennessee | [2]50 | 24 | 48 | [20]30[23] | 46 | 50 | 14 | 20 | 42 | 50 | 50 | 22 | [21]60 | | | | | | 80 | 40 | 70 | [22]74 | 56 | | |
| Texas | 45 | 28 | 48 | | | | | 20 | | 42 | | 22 | 60 | | | | | | 80 | | 70 | 72 | 56 | | |
| Utah | | | | | | | | | | | | | | | | | | | | | | | | | |
| Vermont | 46 | | 48 | 62 | | 60 | | | | 48 | 50 | | 60 | | | | | | | | | | | | |
| Virginia | | 28 | 48 | [5]60 | | | 14 | | | 52 | | | 60 | | | | | | 80 | | 70 | | 56 | 50 | |
| Washington | [2]45 | 28 | 48 | | | | | | | 42 | | | 69 | | | | | | | | | | | | |
| West Virginia | | 25 | 48 | 60 | | | | | | 52 | | | 60 | | 80 | | | | | 56 | | | | | |
| Wisconsin | 50 | 25 | 48 | 60 | | 50 | | 20 | | 50 | 50 | | 60 | | | | | | | | | | | 50 | |
| Wyoming | | | | | | | | | | | | | | | | | | | | | | | | | |

* Not defined.

[1] Small white beans, 60 pounds.
[2] Green apples.
[3] Sugar beets and mangel wurzel.
[4] Shelled beans, 60 pounds; velvet beans, 78 pounds.
[5] White beans.
[6] Wheat bran.
[7] Corn in ear, 70 pounds until Dec. 1 next after grown; 68 pounds thereafter.
[8] In the cob.
[9] English blue-grass seed, 22 pounds; native blue-grass seed, 14 pounds.
[10] Indian corn in ear.
[11] Corn in ear, from Nov. 1 to May 1 following, 70 pounds; 68 pounds from May 1 to Nov. 1.
[12] Indian corn meal.
[13] Soy beans.
[14] Cracked corn.
[15] Green unshelled beans, 30 pounds; green shelled beans, 56 pounds.
[16] Commercially dry, for all hard woods.
[17] Fifteen pounds commercially dry, for all soft woods.
[18] Standard weight in Bureau of Greensburg.
[19] Standard weight bushel corn meal bolted or unbolted, 48 pounds.
[20] Dried beans.
[21] Red and white.
[22] Green unshelled corn, 100 pounds.
[23] Green beans in pod.

LEGAL WEIGHTS (IN POUNDS) PER BUSHEL—*Continued.*

| States and Territories. | Corn Meal, Bolted. | Corn Meal, Unbolted. | Cotton Seed. | | | Cranberries. | Flaxseed (linseed). | Gooseberries. | Plastering Hair. | Hemp Seed. | Herds Grass. | Hungarian Grass Seed. | Indian Corn or Maize. | Lime. | | Malt. | Millet. | Oats. | Onions. | | Orchard Grass Seed. | Osage Orange Seed. | Parsnips. | Peaches. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Cotton Seed.* | Sea Island Cottonseed. | Upland Cotton Seed. | | | | | | | | | Lime.* | Unslaked Lime. | | | | Onions.* | Onion Sets. | | | | Peaches.* | Dri'd Peaches, Peeled. |
| United States | | | | | | | 56 | | | | | | | | | 34 | | 32 | | | | | | | |
| Alabama | | | 32 | | | | | | | | | | | | | | | 32 | | | | | | | 38 |
| Arizona | | | | | | | | | | | | | | | | | | 32 | | | | | | | |
| Arkansas | | | 33½ | | | | 56 | | | | | | | | | | 50 | 32 | 57 | | | | | | 33 |
| California | | | | | | | | | | | | | | | | | | | | | | | | | |
| Colorado | | | | | | | | | | 44 | | | 55 | 80 | | | | 32 | 57 | | | | | | |
| Connecticut | | | | 44 | 30 | | 55 | | | | 45 | | 56 | 70 | | | | 32 | 52 | | | | 45 | | 33 |
| Delaware | 44 | 48 | | | | | | | | | | | 55 | | | | | | | | | | | | |
| Dist. of Columbia | | | | | | | | | | | | | | | | | | | | | | | | | |
| Florida | | | 32 | 46 | | | | | | | | | | | | | 50 | 32 | 56 | | | | | 154 | 33 |
| Georgia | | | 30 | | | | 56 | | 8 | 44 | | | | | 80 | | | 32 | 57 | | | | | | 38 |
| Hawaii | | | | | | | | | | | | | 55 | | | | | 32 | | | | | | | |
| Idaho | | | | | | | 56 | | | | | | 55 | | | | | 36 | | | | | | | |
| Illinois | | | | | | | 56 | | 8 | 44 | | | | | 80 | 38 | | 32 | 57 | | | | | | |
| Indian Territory | | | | | | | | | | | | | | | | | | | | | | | | | |
| Indiana | | | | | | 33 | | | | 44 | | | | | | 235 | 50 | 32 | 48 | | 14 | 33 | 55 | | |
| Iowa | | | | | | | 56 | 40 | | 44 | | 50 | | 80 | | | 50 | 32 | 57 | | | 32 | | 48 | |
| Kansas | | | | | | | 56 | | 8 | 44 | | 50 | 55 | | 80 | | 50 | 32 | 57 | | | | | | |
| Kentucky | | | | | | | 55 | | 8 | 44 | | 50 | | | 35 | | 50 | 32 | 57 | 536 | 14 | | | | 39 |
| Louisiana | | | | | | | | | | | | | | | | | | | | | | | | | |
| Maine | | | | | | | | | 11 | | | | | | | | | 30 | 52 | | | | | | |
| Maryland | | | | | | | | | | | | | | | | | | 26 | | | | | | | |
| Massachusetts | | | | 44 | 30 | | 55 | | | | 45 | | 56 | 70 | | | | 32 | 52 | | | | | | 33 |
| Michigan | | | | | | 40 | 56 | | | 44 | | 50 | | 70 | | | 50 | 32 | 54 | | 14 | 33 | | | 28 |

## LEGAL WEIGHTS (IN POUNDS) PER BUSHEL—*Continued.*

| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Minnesota | | | | | | 36 | | 40 | [3]8 | 50 | | 48 | | 80 | | | 48 | 32 | 52 | | 14 | | 42 | | 28 |
| Mississippi | 44 | 48 | 32 | | | 56 | | | 44 | | 50 | | | 80 | 38 | 50 | 32 | 57 | | | | | | 33 |
| Missouri | | | 33 | | | 56 | | | 44 | | 48 | | | | 38 | 50 | 32 | 57 | [7]28 | 14 | 36 | 44 | 48 | 33 |
| Montana | | | | | | 56 | | | 44 | | 50 | | | 80 | 30 | | 32 | 57 | | | | 50 | | |
| Nebraska | | | | | | 56 | | 8 | 44 | | 50 | | | 80 | 30 | 50 | 32 | 57 | 25 | | 32 | | | 33 |
| Nevada | | | | | | | | | | | | | | | | | | | | | | | | |
| New Hampshire | | | | | | | | | | | | | | | | | 32 | | | | | | | |
| New Jersey | | | | | | 55 | | | | | | 56 | | | | | 30 | 57 | | | | | | 33 |
| New Mexico | | | | | | | | | | | | | | | | | | | | | | | | |
| New York | | | | 44 | 30 | 55 | | | | 45 | | 56 | 70 | | | | 32 | 57 | | | | | | 33 |
| North Carolina | 46 | 48 | 30 | | | 55 | | | | | | 56 | | | | | 32 | | | | | | | |
| North Dakota | | | | | | | | | | | | | | | | 50 | 32 | 52 | | | | | | |
| Ohio | | | | | | 56 | | | 44 | | 50 | | 70 | | 34 | 50 | 32 | 55 | | | | | 48 | 33 |
| Oklahoma | | | | | | 56 | | | | | | | 80 | | | | 32 | 52 | | | | | | |
| Oregon | | | | | | | | | | | | 56 | | | | | 32 | | | | | | | 28 |
| Pennsylvania | | | | | | | | | | | | 56 | | | | | 32 | 50 | | | | | | |
| Rhode Island | | | | 44 | 30 | 56 | | | 44 | | 50 | | 70 | | 38 | 50 | 32 | 50 | | | | 50 | 48 | 33 |
| South Carolina | 46 | 48 | 30 | | | | | | | | | | | | | | | | | | | | | |
| South Dakota | | | | | | 56 | | | | | | | 80 | | | | 32 | 52 | | | | | | |
| Tennessee | 50 | 48 | 28 | | | 56 | 48 | 8 | 44 | | 48 | | (8) | 80 | | [9]50 | 32 | [10]56 | [7]28[11] | 14 | 33 | 50 | [10]50 | 28* |
| Texas | | | 32 | | | 56 | | | 44 | | 48 | | | | | 50 | 32 | 57 | | | | | 50 | 28 |
| Utah | | | | | | | | | | | | | | | | | | | | | | | | |
| Vermont | | | | | | | | | | 45 | | 56 | | | | | 32 | 52 | | | | | | |
| Virginia | | | 32 | | | 56 | | 8 | 44 | 12 | 48 | | | 80 | 38 | 50 | 30 | 57 | 28 | 14 | 34 | | | 40 |
| Washington | | | | | | 53 | | | | | | 56 | | | | | 32 | | | | | | | 28 |
| West Virginia | | | | | | 56 | | | | | | | | | | | 32 | | | | | | | 33 |
| Wisconsin | | | | 44 | 30 | 56 | | | 44 | | 48 | 56 | 70 | 80 | 34 | 50 | 32 | 57 | | | | 44 | | 33 |
| Wyoming | | | | | | | | | | | | | | | | | | | | | | | | |

* Not defined.

[1] Green peaches.
[2] Rye malt.
[3] Unwashed plastering hair, 8 pounds; washed plastering hair, 4 pounds.
[4] Shelled.
[5] Bottom onion sets.
[6] Strike measure.
[7] Top onion sets, 28 pounds.
[8] Slaked lime, 40 pounds.
[9] German Missouri and Tennessee millet seed.
[10] Matured.
[11] Button onion sets, 32 pounds.

LEGAL WEIGHTS (IN POUNDS) PER BUSHEL—*Continued.*

| States and Territories. | D'd Peaches, Unpeeled. | Peanuts. | Peas. | | | Pears.* | Potatoes. | | | Red Top. | Rough Rice. | Rice Corn. | Rutabagas. | Rye Meal. | Rye | Salt. | | | Shorts.* | Sorghum Seed. | Tomatoes. | Timothy Seed. | Turnips. | | Wheat. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Ground Peas. | Green Peas, Unshelled. | Peas.* | | Potatoes.* | Sweet Potatoes. | White Potatoes. | | | | | | | Salt.* | Fine Salt. | Coarse Salt. | | | | | Turnips.* | C'mon English Turnips. | |
| United States | | | | | 60 | | 60 | | | | | | | | 56 | | | | | | | | | | 60 |
| Alabama | 33 | | | | 60 | | | 55 | 60 | | | | | | 56 | | | | | | | | 55 | | 60 |
| Arizona | | | | | | | 60 | 50 | 60 | | | | | | 56 | | | | | | | | | | 60 |
| Arkansas | 33 | | | | 60 | | | | | 14 | | | | | 56 | 50 | | | | 50 | | 60 | 57 | | 60 |
| California | | | | | | | | | | | | | | | | | | | | | | | | | |
| Colorado | | | | | | | 60 | | | | | | | | 56 | 80 | | | | | | 45 | | | 60 |
| Connecticut | 33 | | | | 60 | | 60 | 54 | 60 | | 45 | | 60 | 50 | 56 | | 50 | 70 | 20 | | | | | 50 | 60 |
| Delaware | | | | | | | | | | | | | | | | | | | | | | | | | 60 |
| Dist. of Columbia | | | | | | | 60 | | | | | | | | | | | | | | | | | | |
| Florida | | 22 | | | | 60 | | 60 | 60 | | | | | | 56 | 60 | | | | 56 | | | 54 | | 60 |
| Georgia | 33 | | 25 | | 60 | | | 55 | 60 | | 43 | | | | 56 | | | | | | | 45 | 55 | | 60 |
| Hawaii | | | | | | | | | | | | | | | 56 | | | | | | | | | | 60 |
| Idaho | 28 | | | | | 145 | 60 | | | | | | | | 56 | | | | | | | | | | 60 |
| Illinois | 33 | | | | | | | 50 | 60 | | | | | | 56 | | 55 | 50 | | | | 45 | 55 | | 60 |
| Indian Territory | | | | | | | | | | | | | | | | | | | | | | | | | |
| Indiana | 33 | | | | | | 60 | 55 | | | | | | | 56 | 50 | | | | | | 45 | 55 | | 60 |
| Iowa | 33 | | | | | | 60 | 46 | | | | | | | 56 | 50 | | | | 230 | | 45 | | | 60 |
| Kansas | 33 | | | | | | 60 | 50 | | | | 56 | | | 56 | 50 | | | | 56 | | 45 | 55 | | 60 |
| Kentucky | | | 24 | | 60 | | 60 | 55 | 60 | | | | | | 56 | 50 | 55 | | | | | 45 | 60 | | 60 |
| Louisiana | | | | | | | | | | | | | | | | | | | | | | | | | |
| Maine | | | | | 60 | | 60 | | | | | | 60 | 50 | | | 60 | 70 | | | | | | 50 | 60 |
| Maryland | | | | | | | 56 | | | | | | | | | | | | | | 60 | | | | |
| Massachusetts | | | | | 60 | | 60 | 54 | | | 45 | | | 50 | 56 | | 50 | 70 | 20 | | | 45 | | | 60 |

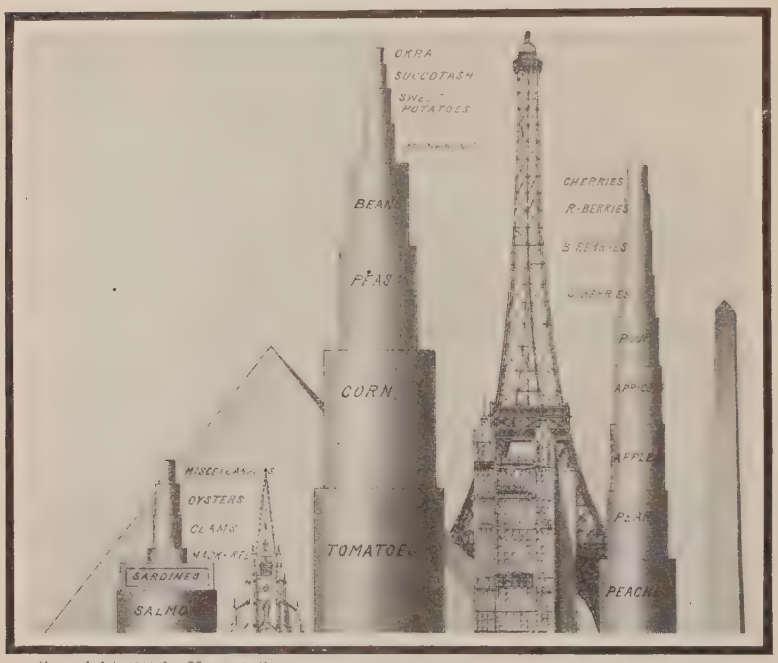
LEGAL WEIGHTS (IN POUNDS) PER BUSHEL—*Continued.*

| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Michigan | | | | | 60 | | | 56 | 60 | [3]14 | | | | | 56 | 56 | | | | | | | 45 | 58 | | 60 |
| Minnesota | | | | | 60 | | | 55 | 60 | [3]14 | | | 52 | | 56 | | | | | | 57 | | 45 | | | 60 |
| Mississippi | | | 24 | | 60 | | | 60 | 60 | | | | | | 56 | 50 | | | | | 42 | | 45 | 55 | | 60 |
| Missouri | | | | 56 | [4]60 | 48 | | 56 | 60 | [3]14 | | | 50 | | 56 | 50 | | | | | 42 | 45 | 45 | | 42 | 60 |
| Montana | | | | | 60 | 48 | 60 | | | | | | | | 56 | 50 | | | | | | | 45 | 50 | | 60 |
| Nebraska | | | | | 60 | | | 50 | 60 | | | | | | 56 | 50 | | | | | 30 | | 45 | 55 | | 60 |
| Nevada | | | | | | | | | | | | | | | | | | | | | | | | | | |
| New Hampshire | | | | | 60 | | 60 | | | | | | | 50 | 56 | | | | | | | | | | | 60 |
| New Jersey | | | | | 60 | | | 54 | 60 | | | | | | 56 | | | | | | | | | | | 60 |
| New Mexico | | | | | | | | | | | | | | | | | | | | | | | | | | |
| New York | | | | | 60 | | | 54 | 60 | | 45 | | | 50 | 56 | | 56 | 70 | 20 | | | | 45 | | | 60 |
| North Carolina | | 22 | | | 60 | | | | | | 44 | | | | 56 | | | | | | | | | | | 60 |
| North Dakota | | | | | 60 | | | 46 | 60 | | | | | | 56 | 80 | | | | | | | 45 | 60 | | 60 |
| Ohio | | | | | 60 | | | 50 | 60 | | | | | | 56 | | | | | | | 56 | 45 | 60 | | 60 |
| Oklahoma | | | | | 60 | | | 46 | 60 | | | | | | 56 | 80 | | | | | | | 42 | 60 | | 60 |
| Oregon | | | | | | 45 | 60 | | | | | | | | 56 | | | | | | | | | | | 60 |
| Pennsylvania | | | | | | | 56 | | | | | | | | 56 | | | | | | | | | | | 60 |
| Rhode Island | | | | | [4]60 | | | 54 | 60 | | | | | 50 | 56 | | 50 | 70 | 20 | | 56 | 45 | 50 | | | 60 |
| South Carolina | | | | | | | | | | | | | | | | | | | | | | | | | | |
| South Dakota | | | | | 60 | | | 46 | 60 | | | | | | 56 | 80 | | | | | | | 42 | 60 | | 60 |
| Tennessee | | 23 | | 30 | [8]60 | [5]56 | | 50 | 60 | 14 | | | | | 56 | 50 | | | | | 50 | 56 | 45 | 50 | | 60 |
| Texas | | | | | | | | 55 | 60 | | | | | | 56 | 50 | | | | | | 55 | 45 | 55 | | 60 |
| Utah | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Vermont | | | | | 60 | | 60 | | | | | | | | 56 | 70 | | | | | | | 45 | 60 | | [7]60 |
| Virginia | 32 | 22 | | | [6]60 | | | 56 | 60 | 12 | | | | | 56 | 50 | | | | | | | 45 | 55 | | 60 |
| Washington | | | | | | [1]45 | 60 | | | | | | | | 56 | | | | | | | | | | | 60 |
| West Virginia | | | | | | | 60 | | | | | | | | 56 | | | | | | | | 45 | | | 60 |
| Wisconsin | | | | | 60 | | | 54 | 60 | | 45 | | 56 | 50 | 56 | | 50 | 70 | 20 | | | | 45 | 42 | | 60 |
| Wyoming | | | | | | | | | | | | | | | | | | | | | | | | | | |

* Not defined.

[1] Green.
[2] Sorghum saccharatum seed.
[3] Seed.
[4] Including split peas.
[5] Matured pears, 56 pounds; dried pears, 26 pounds.
[6] Black-eyed peas.
[7] India wheat, 46 pounds.
[8] Dry.

—U. S. Bureau of Standards.

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COMPARISON OF CANNED GOODS PUT UP IN THE UNITED STATES IN 1900.

CANS, TIN.—Size of sheet for from 1 to 100 gallons.

| | | | | | |
|---|---|---|---|---|---|
| For | 1 | gal. | 10×20 in. | For 25 gal. | 30×56 in. |
| " | 3½ | " | 10 · 28 " | " 40 " | 36 · 63 " |
| " | 5 | " | 12×40 " | " 50 " | 40×70 " |
| " | 6 | " | 14×40 " | " 75 " | 40×84 " |
| " | 10 | " | 20×42 " | " 100 " | 40×98 " |
| " | 15 | " | 30×42 " | | |

This includes all the laps, seams, etc. Is sufficiently correct for all practical purposes.

WIRE, *to Ascertain Amount Required for Cable.*—For the length of a wire in a strand, add to a given length as many times the circumference of the strand as there are twists in the given length, for the outside wires; and proportionately for the inner row. The centre wire is supposed to be straight. Proceed in the same way for the strands. The excess of wire in each strand added to the excess of the strands over the length of the cable will give the whole length of wire used.

# CHAPTER XVI.

## MISCELLANEOUS INFORMATION.

### CENTRAL ELECTRIC LIGHT AND POWER STATIONS, UNITED STATES: 1902.

| ITEMS. | Total. | Private stations. | Municipal stations. |
|---|---|---|---|
| Number of stations | 3,620 | 2,805 | 815 |
| Condensed statement—income and expenses: | | | |
| Earnings from operation, total | $84,186,605 | $77,349,749 | $6,836,856 |
| Arc lighting | $25,481,045 | $22,091,800 | $3,389,245 |
| Incandescent lighting | $44,657,102 | $41,297,484 | $3,359,618 |
| All other electric service | $14,048,458 | $13,960,465 | $87,993 |
| Income from all other sources | $1,514,000 | $1,385,751 | $128,249 |
| Gross income | $85,700,605 | $78,735,500 | $6,965,105 |
| Expenses, total | $68,081,375 | $62,835,388 | $5,245,987 |
| Salaries and wages | $20,646,692 | $18,766,970 | $1,879,722 |
| Supplies, materials, and fuel | $22,915,932 | $20,493,641 | $2,422,291 |
| Rents, taxes, insurance, and miscellaneous | $11,895,206 | $11,456,037 | $439,169 |
| Interest on bonds | $12,623,545 | $12,118,740 | $504,805 |
| Analysis of income. | | | |
| Aggregate | $85,700,605 | $78,735,500 | $6,965,105 |
| Arc lighting, total | $25,481,045 | $22,091,800 | $3,389,245 |
| Commercial or other private | $8,460,320 | $8,220,154 | $240,166 |
| Public | $17,020,725 | $13,871,646 | $3,149,079 |
| Incandescent lighting, total | $44,657,102 | $41,297,484 | $3,359,618 |
| Commercial or other private | $41,907,853 | $39,039,557 | $2,868,296 |
| Public | $2,749,249 | $2,257,927 | $491,322 |
| Motor service | $9,910,217 | $9,839,677 | $70,540 |
| Electric railway service | $2,304,515 | $2,301,343 | $3,172 |
| Electric heating | $39,213 | $39,155 | $58 |
| Charging automobiles | $30,056 | $29,959 | $97 |
| All other electric service | $1,764,457 | $1,750,331 | $14,126 |
| All other sources | $1,514,000 | $1,385,751 | $128,249 |
| Analysis of supplies, materials, and fuel: | | | |
| Aggregate cost | $22,915,932 | $20,493,641 | $2,422,291 |
| Meters— | | | |
| Number | 27,632 | 25,739 | 1,893 |
| Cost | $416,994 | $390,569 | $26,425 |
| Motors | | | |
| Number | 602 | 572 | 30 |
| Cost | $30,099 | $29,202 | $897 |
| Transformers— | | | |
| Number | 13,288 | 7,843 | 5,445 |
| Cost | $365,028 | $326,407 | $38,621 |
| Incandescent lamps— | | | |
| Number | 8,839,905 | 8,399,571 | 440,334 |
| Cost | $1,507,249 | $1,426,224 | $81,025 |
| Incandescent lamp fittings, sockets, etc., cost | $177,236 | $154,517 | $22,719 |
| Carbons for arc lamps— | | | |
| Number | 94,686,596 | 82,156,930 | 12,529,666 |
| Cost | $1,051,386 | $900,788 | $150,598 |
| Globes for arc lamps— | | | |
| Number | 485,073 | 428,979 | 56,094 |
| Cost | $170,929 | $150,509 | $20,420 |
| Arc lamp repairs, cost | $244,537 | $212,231 | $32,306 |
| Poles or other supports, cost | $346,587 | $319,617 | $26,970 |
| Wire and cable cost | $1,152,915 | $1,081,380 | $71,535 |
| Mill supplies (oil, waste, etc.), cost | $712,797 | $617,911 | $94,886 |
| All other materials, cost | $1,853,544 | $1,747,896 | $105,648 |
| Power purchased, cost | $2,130,759 | $2,007,193 | $123,566 |
| Freight paid, not included in other items | $1,120,363 | $939,512 | $180,851 |

CENTRAL ELECTRIC LIGHT AND POWER STATIONS, UNITED STATES, 1902—*Continued.*

| ITEMS. | Total. | Private stations. | Municipal stations. |
|---|---|---|---|
| Analysis of supplies, materials, and fuel—*Contin'd:* | | | |
| Fuel, cost | $11,635,509 | $10,189,685 | $1,445,824 |
| Coal— | | | |
| Tons | 4,817,597 | 4,249,137 | 568,460 |
| Cost | $9,943,125 | $8,749,394 | $1,193,731 |
| Crude petroleum, cost | $721,838 | $700,136 | $21,702 |
| Natural gas, cost | $254,269 | $220,460 | $33,809 |
| Manufactured gas, cost | $28,654 | $20,135 | $8,519 |
| All other fuel, cost | $687,623 | $499,560 | $188,063 |
| Average number of employees, total salaries, wages: | | | |
| Salaried officials and clerks— | | | |
| Average number, total | 6,996 | 6,046 | 950 |
| Salaries, total | $5,663,580 | $5,206,199 | $457,381 |
| General officers— | | | |
| Average number | 1,587 | 1,416 | 171 |
| Salaries | $1,501,522 | $1,465,471 | $36,051 |
| Other officers, managers, superintendents, etc.— | | | |
| Average number | 2,393 | 1,875 | 518 |
| Salaries | $2,445,227 | $2,088,298 | $356,929 |
| Clerks— | | | |
| Average number | 3,016 | 2,755 | 261 |
| Salaries | $1,716,831 | $1,652,430 | $64,401 |
| Wage-earners— | | | |
| Average number, total | 23,330 | 20,863 | 2,467 |
| Wages, total | $14,983,112 | $13,560,771 | $1,422,341 |
| Foremen— | | | |
| Average number | 1,000 | 943 | 57 |
| Wages | $953,738 | $910,972 | $42,766 |
| Inspectors— | | | |
| Average number | 571 | 546 | 25 |
| Wages | $415,904 | $397,983 | $17,921 |
| Engineers— | | | |
| Average number | 4,587 | 3,743 | 844 |
| Wages | $3,259,870 | $2,721,127 | $538,743 |
| Firemen— | | | |
| Average number | 3,456 | 2,951 | 505 |
| Wages | $1,963,465 | $1,717,149 | $246,316 |
| Dynamo and switchboard men— | | | |
| Average number | 1,978 | 1,872 | 106 |
| Wages | $1,351,676 | $1,286,065 | $65,611 |
| Linemen— | | | |
| Average number | 4,217 | 3,868 | 349 |
| Wages | $2,710,841 | $2,510,269 | $200,572 |
| Mechanics— | | | |
| Average number | 1,057 | 1,009 | 48 |
| Wages | $796,355 | $768,694 | $27,661 |
| Lamp trimmers— | | | |
| Average number | 2,637 | 2,318 | 319 |
| Wages | $1,654,462 | $1,460,046 | $194,416 |
| All other employees— | | | |
| Average number | 3,827 | 3,613 | 214 |
| Wages | $1,876,801 | $1,788,466 | $88,335 |
| Analysis of miscellaneous expenses: | | | |
| Total | $11,895,206 | $11,456,037 | $439,169 |
| Rent of stations, supports, conduits, etc | $1,011,691 | $1,001,504 | $10,187 |
| Rent of offices | $275,007 | $270,446 | $4,561 |
| Taxes | $2,665,005 | $2,654,885 | $10,120 |
| Injuries and damages | $248,304 | $246,545 | $1,759 |
| Insurance | $893,567 | $827,926 | $65,641 |
| Ordinary repairs of buildings and mach'y | $2,701,747 | $2,480,217 | $221,530 |
| All other | $4,099,885 | $3,974,514 | $125,371 |
| Electric line construction: | | | |
| Aggregate miles— | | | |
| Mains | 107,263.63 | 93,352.95 | 13,910.68 |
| Feeders | 17,880.51 | 16,452.28 | 1,428.23 |
| Lighting and stationary motor service, miles— | | | |
| Mains, total | 107,184.13 | 93,273.45 | 13,910.68 |
| Feeders, total | 17,760.26 | 16,332.03 | 1,428.23 |

CENTRAL ELECTRIC LIGHT AND POWER STATIONS, UNITED STATES, 1902—*Continued.*

| ITEMS. | Total. | Private stations. | Municipal stations. |
|---|---|---|---|
| Electric line construction—*Continued:* | | | |
| Underground— | | | |
| Mains | 5,847.71 | 5,408.55 | 439.16 |
| Feeders | 2,276.55 | 2,262.02 | 14.53 |
| Overhead— | | | |
| Mains | 101,304.26 | 87,833.63 | 13,470.63 |
| Feeders | 15,472.34 | 14,061.50 | 1,410.84 |
| Submarine— | | | |
| Mains | 32.16 | 31.27 | 0.89 |
| Feeders | 11.37 | 8.51 | 2.86 |
| Electric railway car service owned by lighting companies, miles— | | | |
| Mains | 79.50 | 79.50 | ..... |
| Feeders | 120.25 | 120.25 | ..... |
| Power and generating equipment: | | | |
| Steam engines—Number, total | 5,930 | 4,870 | 1,060 |
| Horsepower, total | 1,379,941 | 1,232,923 | 147,018 |
| 500 horsepower and under— | | | |
| Number | 5,451 | 4,407 | 1,044 |
| Horsepower | 849,336 | 715,418 | 133,918 |
| Over 500 and under 1,000 horsepower | | | |
| Number | 278 | 266 | 12 |
| Horsepower | 193,570 | 184,670 | 8,900 |
| 1,000 horsepower and over— | | | |
| Number | 201 | 197 | 4 |
| Horsepower | 337,035 | 332,835 | 4,200 |
| Water wheels— | | | |
| Number, total | 1,390 | 1,308 | 82 |
| Horsepower, total | 438,472 | 427,254 | 11,218 |
| 500 horsepower and under— | | | |
| Number | 1,187 | 1,107 | 80 |
| Horsepower | 173,903 | 164,325 | 9,578 |
| Over 500 and under 1,000 horsepower | | | |
| Number | 90 | 89 | 1 |
| Horsepower | 57,816 | 57,176 | 640 |
| 1,000 horsepower and over— | | | |
| Number | 113 | 112 | 1 |
| Horsepower | 206,753 | 205,753 | 1,000 |
| Gas engines— | | | |
| Number | 165 | 147 | 18 |
| Horsepower | 12,181 | 11,224 | 957 |
| Auxiliary steam engines— | | | |
| Number | 365 | 329 | 36 |
| Horsepower | 14,454 | 13,619 | 835 |
| Dynamos— | | | |
| Number, total | 12,484 | 10,662 | 1,822 |
| Horsepower, total | 1,624,980 | 1,472,996 | 151,984 |
| Direct current, constant voltage— | | | |
| Number | 3,823 | 3,405 | 418 |
| Horsepower | 442,446 | 418,913 | 23,533 |
| Direct current, constant amperage— | | | |
| Number | 3,539 | 2,957 | 582 |
| Horsepower | 195,531 | 157,768 | 37,763 |
| Alternating and polyphase current— | | | |
| Number | 5,122 | 4,300 | 822 |
| Horsepower | 987,003 | 896,315 | 90,688 |
| Boosters— | | | |
| Number | 193 | 184 | 9 |
| Horsepower | 17,911 | 17,735 | 176 |
| Rotaries— | | | |
| Number | 132 | 131 | 1 |
| Horsepower | 63,817 | 63,683 | 134 |
| Storage battery cells in main plants— | | | |
| Number | 6,881 | 5,981 | 900 |
| Horsepower | 16,355 | 16,335 | 20 |
| Substation plants: | | | |
| Horsepower, total | 552,950 | 551,467 | 1,483 |
| Storage battery cells— | | | |
| Number | 8,388 | 8,388 | ..... |
| Horsepower | 25,284 | 25,284 | ..... |

CENTRAL ELECTRIC LIGHT AND POWER STATIONS, UNITED STATES, 1902—*Continued.*

| ITEMS. | Total. | Private stations. | Municipal stations. |
|---|---|---|---|
| Substation plants—*Continued:* | | | |
| Transformers— | | | |
| Number | 2,525 | 2,490 | 35 |
| Horsepower | 420,667 | 419,368 | 1,299 |
| Rotary converters— | | | |
| Number | 163 | 162 | 1 |
| Horsepower | 85,556 | 85,546 | 10 |
| Miscellaneous— | | | |
| Number | 140 | 135 | 5 |
| Horsepower | 21,443 | 21,269 | 174 |
| Transformers on circuits for consumers: | | | |
| Number | 207,151 | 179,081 | 28,070 |
| Horsepower | 922,774 | 822,668 | 100,106 |
| Meters on consumers' circuits, total | 582,689 | 526,011 | 56,678 |
| Mechanical | 575,004 | 518,428 | 56,576 |
| Chemical | 7,685 | 7,583 | 102 |
| Output of stations: | | | |
| Kilowatt hours— | | | |
| Total for year | 2,507,051,115 | 2,311,146,676 | 195,904,439 |
| Average per day | 6,960,783 | 6,413,012 | 547,771 |
| Horsepower hours of current— | | | |
| Total for year | 3,341,943,070 | 3,083,212,074 | 258,731,016 |
| Average per day | 9,294,456 | 8,566,231 | 728,225 |
| Analysis of service: | | | |
| Arc lighting—number of lamps in service— | | | |
| Aggregate | 385,698 | 334,903 | 50,795 |
| Commercial or other private, total | 173,973 | 168,180 | 5,793 |
| Open | 42,988 | 41,622 | 1,366 |
| Inclosed | 130,985 | 126,558 | 4,427 |
| Direct current | 104,176 | 101,849 | 2,327 |
| Open | 38,120 | 36,856 | 1,264 |
| Inclosed | 66,056 | 64,993 | 1,063 |
| Alternating current | 67,538 | 64,085 | 3,453 |
| Open | 3,733 | 3,631 | 102 |
| Inclosed | 63,805 | 60,454 | 3,351 |
| All other | 2,259 | 2,246 | 13 |
| Open | 1,135 | 1,135 | ..... |
| Inclosed | 1,124 | 1,111 | 13 |
| Public, total | 211,725 | 166,723 | 45,002 |
| Open | 138,684 | 108,082 | 30,602 |
| Inclosed | 73,041 | 58,641 | 14,400 |
| Direct current | 154,749 | 119,520 | 35,229 |
| Open | 125,298 | 96,659 | 28,639 |
| Inclosed | 29,451 | 22,861 | 6,590 |
| Alternating current | 48,063 | 38,316 | 9,747 |
| Open | 4,630 | 2,681 | 1,949 |
| Inclosed | 43,433 | 35,635 | 7,798 |
| All other | 8,913 | 8,887 | 26 |
| Open | 8,756 | 8,742 | 14 |
| Inclosed | 157 | 145 | 12 |
| Incandescent lighting—lamps in service— | | | |
| Aggregate | 18,194,044 | 16,616,593 | 1,577,451 |
| Commercial or other private, total | 17,738,384 | 16,243,853 | 1,494,531 |
| 16-candlepower | 15,261,067 | 13,890,281 | 1,370,786 |
| 32-candlepower | 514,679 | 484,246 | 30,433 |
| All other candlepower | 1,962,638 | 1,869,326 | 93,312 |
| Public, total | 455,660 | 372,740 | 82,920 |
| 16-candlepower | 296,776 | 235,842 | 60,934 |
| 32-candlepower | 59,988 | 47,063 | 12,925 |
| All other candlepower | 98,896 | 89,835 | 9,061 |
| Motors in service— | | | |
| Stationary— | | | |
| Number | 101,064 | 99,102 | 1,962 |
| Horsepower | 624,686 | 619,283 | 5,403 |
| Railway car, number of cars served | 2,379 | 2,370 | 9 |
| Character of ownership: | | | |
| When installed— | | | |
| Individual | 1,041 | 964 | 77 |
| Corporation | 1,921 | 1,828 | 93 |
| Municipal | 658 | 13 | 645 |

## CENTRAL ELECTRIC LIGHT AND POWER STATIONS, UNITED STATES, 1902—*Continued.*

| ITEMS. | Total. | Private stations. | Municipal stations. |
|---|---|---|---|
| Character of ownership—*Continued:* | | | |
| In 1902— | | | |
| Individual | 756 | 756 | ..... |
| Corporation | 2,049 | 2,049 | ..... |
| Municipal | 815 | ..... | 815 |
| Character of service: | | | |
| Arc lighting— | | | |
| Commercial or other private | 2,020 | 1,667 | 353 |
| Public | 2,522 | 1,810 | 712 |
| Incandescent lighting— | | | |
| Commercial or other private | 3,484 | 2,752 | 732 |
| Public | 2,491 | 1,889 | 602 |
| Motor power— | | | |
| Stationary | 1,093 | 975 | 118 |
| Electric railway | 159 | 157 | 2 |
| All other | 161 | 152 | 9 |
| Stocks and bonds issued, total par value | $639,125,363 | $627,515,875 | $11,609,488 |
| Capital stock: | | | |
| Authorized, total | $435,178,372 | $435,178,372 | ..... |
| Issued, total | $372,951,952 | $372,951,952 | ..... |
| Dividends, total | $6,189,837 | $6,189,837 | ..... |
| Common— | | | |
| Authorized | $407,807,934 | $407,807,934 | ..... |
| Issued | $349,080,281 | $349,080,281 | ..... |
| Dividends | $5,560,341 | $5,560,341 | ..... |
| Preferred— | | | |
| Authorized | $27,370,438 | $27,370,438 | ..... |
| Issued | $23,871,671 | $23,871,671 | ..... |
| Dividends | $629,496 | $629,496 | ..... |
| Bonds: | | | |
| Authorized | $320,743,376 | $308,117,894 | $12,625,482 |
| Outstanding | $266,173,411 | $254,563,923 | $11,609,488 |
| Interest | $12,623,545 | $12,118,740 | $504,805 |
| Cost of construction and equipment: | | | |
| To date | $504,740,352 | $482,719,879 | $22,020,473 |
| During the year | $41,792,447 | $40,050,613 | $1,741,834 |

—*Census Reports.*

## COMPARATIVE VELOCITIES, PER SECOND.

Snail (0.0394 inch), 1 millimeter.
Pedestrian (39.37 inches) 1 meter = 1.09 ya.
Horse, walking, 1.2 meters = 1.31 yards.
Pedestrian, quick walk, 2 meters = 2.19 ya.
Horse, trotting, 3.5 meters = 3.82 yards.
Mild wind, 4 meters = 4.37 yards.
Horse, galloping, 4.5 meters = 4.91 yards.
Steamer, ordinary, 5 meters = 5.47 yards.
Sail-boat, 8 meters = 8.75 yards.
Ocean steamer, 10 meters = 10.93 yards.
Skater, 12 meters = 13.08 yards.
Freight train, 12 meters = 13.08 yards.
Gale, 17 meters = 18.53 yards.
Passenger train, 18 meters = 19.62 yards.
Carrier pigeon, 18 meters = 19.62 yards.
Bicycle, racing, 20 meters = 21.87 yards.
Race horse, 25 meters = 27.05 yards.
Express train, 26 meters = 28.14 yards.
Swallow, 45 meters = 49.05 yards.
Sound, 330 meters = 360.70 yards.
Rifle-ball (breech-loader), 430 meters = 468.70 yards.
Cannon ball, 450 meters = 490.50 yards.
Axial revolution of the earth at equator, 450 meters = 490.50 yards.
Revolutions of the earth around the sun, 30 kilometers = 18.64 miles.
Light, 300,000 kilometers = 186,400 miles.
Electricity, 400,000 kilometers = 248,500 mi.

## TABLE OF ELEVATIONS OF OBJECTS ABOVE SEA LEVEL, WITH THEIR CORRESPONDING DISTANCES OF VISIBILITY.

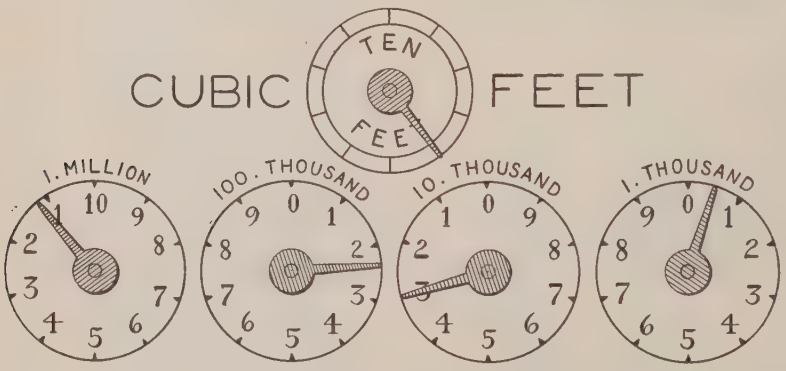
| Height, in Feet. | Distance, in Nautical Miles. | Height, in Feet. | Distance, in Nautical Miles. |
|---|---|---|---|
| 5 | 2.555 | 50 | 8.081 |
| 10 | 3.614 | 100 | 11.428 |
| 15 | 4.426 | 250 | 18.070 |
| 20 | 5.111 | 500 | 25.555 |
| 25 | 5.714 | 1,000 | 36.140 |

Distances corresponding to heights not included in the above table may be found by the formula $D = \frac{3}{2}\sqrt{H}$, in which $H$ = the elevation, or height, in feet, of the object above sea-level, and $D$ = the corresponding distance of visibility, in nautical miles. The formula is based on the mean curvature of the earth and is corrected for ordinary atmospheric refraction.

The distance of visibility of a light may be augmented by abnormal atmospheric refraction, which usually increases with the height of the barometer and a falling temperature.

## HOW TO READ A GAS METER.

The dial marked "1 THOUSAND" in the accompanying illustration is divided into hundreds; the dial marked "10 THOUSAND" is divided into thousands; that marked "100 THOUSAND" into ten-thousands, and that marked "1 MILLION" into hundred-thousands. When 1,000 cubic feet of gas have been consumed, the pointer on the dial marked "1 THOUSAND" will have made a complete rotation and the fact will be indicated by the pointer of the next dial at the left, which will point to the figure 1. When 10,000 cubic feet of gas have been consumed, the pointer on the "10 THOUSAND" dial will point to 1, and so on. In reading a gas meter, put down the hundreds first, then the thousands, and so on, always counting the figure just under, or which has just been passed by, the pointer. In the illustration about half a hundred is indicated on the "1 THOUSAND" dial, three thousands is indicated on the next dial, two ten-thousands on the next dial, and one one-hundred-thousands on the "1 MILLION" dial. The reading will be 123,-050. The dial marked "TEN FEET" is called the units dial. It is used for testing the meter to discover whether it is in working order or not. Each mark represents a cubic foot and the complete circle 10 cubic feet. If the pointer moves when no gas is burning, it indicates a leak. If it does not move when the gas is burning, or if its motion is unsteady, it indicates a derangement in the mechanism and shows that the meter requires attention.




GAS METER INDICATOR DIALS.

PAPER CURRENCY OF EACH DENOMINATION OUTSTANDING MAY 31, 1904.
[Prepared by Treasurer's Office.]

| Denomination. | United States Notes. | Treasury Notes of 1890. | National-bank Notes. | Gold Certificates. | Silver Certificates. | Total. |
|---|---|---|---|---|---|---|
| | Dollars | Dollars. | Dollars. | Dollars. | Dollars. | Dollars. |
| One dollar | 1,923,494 | 636,992 | 345,145 | ..... | 79,851,727 | 82,757,358 |
| Two dollars | 1,472,334 | 486,068 | 165,282 | ..... | 45,045,050 | 47,168,734 |
| Five dollars | 12,278,660 | 3,189,330 | 62,602,840 | ..... | 281,708,442 | 359,779,272 |
| Ten dollars | 243,517,011 | 5,679,520 | 188,067,250 | ..... | 39,648,331 | 476,912,112 |
| Twenty dollars | 36,775,242 | 2,488,590 | 140,632,200 | 172,387,164 | 18,658,620 | 370,941,816 |
| Fifty dollars | 5,906,875 | 47,500 | 17,427,600 | 34,727,905 | 5,095,810 | 63,205,690 |
| One hundred dollars | 11,200,900 | 510,000 | 36,591,500 | 51,145,300 | 1,493,020 | 100,940,720 |
| Five hundred dollars | 9,748,500 | ..... | 95,500 | 14,236,000 | 50,000 | 24,130,000 |
| One thousand dollars | 24,838,000 | 435,000 | 24,000 | 56,908,500 | 111,000 | 82,316,500 |
| Fivethousand dollars | 10,000 | ..... | ..... | 49,590,000 | ..... | 49,600,000 |
| Ten thousand dollars | 10,000 | ..... | ..... | 110,980,000 | ..... | 110,990,000 |
| Fractional parts | ..... | ..... | 37,248 | ..... | ..... | 37,248 |
| Total | 347,681,016 | 13,473,000 | 445,988,565 | 489,974,869 | 471,662,000 | 1,768,779,450 |
| Unknown, destroyed | 1,000,000 | ..... | ..... | ..... | ..... | 1,000,000 |
| Net | 346,681,016 | 13,473,000 | 445,988,565 | 489,974,869 | 471,662,000 | 1,767,779,450 |

## AMOUNTS OF GOLD AND SILVER COIN AND CERTIFICATES, UNITED STATES NOTES, AND NATIONAL BANK NOTES IN CIRCULATION AND IN THE TREASURY MAY 1 AND JUNE 1, 1904, RESPECTIVELY.

[NOTE.—Population of the United States, June 1, 1904, estimated at 81,752,000; circulation per capita, $30.69.]

| Classification. | General Stock of Money in the United States, June 1, 1904. | Held in Treasury as Assets of Gov't.,[1] June 1, 1904. | Money in Circulation, June 1, 1904. |
|---|---|---|---|
| | Dollars. | Dollars. | Dollars. |
| Gold coin (including bullion in Treasury) | 1,313,120,868 | 217,592,391 | 644,894,548 |
| Gold certificates [2] | ..... | ..... | 450,633,929 |
| Standard silver dollars | 559,422,410 | 22,659,857 | 72,605,727 |
| Silver certificates [2] | ..... | ..... | 464,156,826 |
| Subsidiary silver | 106,614,930 | 12,035,831 | 94,579,099 |
| Treasury notes of 1890 | 13,473,000 | 98,576 | 13,374,424 |
| United States notes | 346,681,016 | 9,376,636 | 337,304,380 |
| Currency certificates, act of June 8, 1872 [2] | ..... | ..... | ..... |
| National-bank notes | 445,988,565 | 14,257,581 | 431,730,984 |
| Total | 2,785,300,789 | 276,020,872 | 2,509,279,917 |

[1] This statement of money held in the Treasury as assets of the Government does not include deposits of public money in national-bank depositaries to the credit of the Treasurer of the United States, and amounting to $106,849,757.45.

[2] For redemption of outstanding certificates an exact equivalent in amount of the appropriate kinds of money is held in the Treasury, and is not included in the account of money held as assets of the Government.

## PUBLIC DEBT OF THE UNITED STATES.

| Classification. | May 31, 1904. |
|---|---|
| | Dollars. |
| Interest-bearing debt | 895,157,430.00 |
| Debt on which interest has ceased since maturity | 2,109,950.26 |
| Debt bearing no interest | 391,321,769.38 |
| Aggregate of interest and non-interest bearing debt | 1,288,589,149.64 |
| Certificates and Treasury notes offset by an equal amount of cash in the Treasury | 975,109,869.00 |
| Aggregate of debt, including certificates and Treasury notes | 2,263,699,018.64 |

GOLD BARS, VALUE $100 TO $8,000 EACH.

## VALUES OF FOREIGN COINS.

TREASURY DEPARTMENT,
OFFICE OF THE SECRETARY, *Washington, July* 1, 1905.

In pursuance of the provisions of section 25 of the act of August 28, 1894, I hereby proclaim the following estimate by the Director of the Mint of the values of foreign coins to be the values of such coins in terms of the money of account of the United States, to be followed in estimating the value of all foreign merchandise exported to the United States on and after July 1, 1905, expressed in any of such metallic currencies.

C. H. KEEP, *Acting Secretary.*

| COUNTRY. | Standard. | Monetary unit. | Value in terms of U. S. gold dollar. | Coins. |
|---|---|---|---|---|
| Argentine Republic | Gold | Peso | $0.965 | Gold: argentine ($4.824) and ½ argentine. Silver: peso and divisions. |
| Austria-Hungary | Gold | Crown | .203 | Gold: 10 and 20 crowns. Silver: 1 and 5 crowns. |
| Belgium | Gold | Franc | .193 | Gold: 10 and 20 francs. Silver: 5 francs. |
| Bolivia | Silver | Boliviano | .422 | Silver: boliviano and divisions. |
| Brazil | Gold | Milreis | .546 | Gold: 5, 10, and 20 milreis. Silver: ½, 1, and 2 milreis. |
| British Possessions, N. A. (except Newf'nd). | Gold | Dollar | 1.000 | |
| Central Amer. States. | | | | |
| Costa Rica | Gold | Colon | .465 | Gold: 2, 5, 10, and 20 colons ($9.307). Silver: 5, 10, 25, and 50 centimos. |
| British Honduras | Gold | Dollar | 1.000 | |
| Guatemala, Honduras, Nicaragua, Salvador | Silver | Peso | .422 | Silver: peso and divisions. |
| Chile | Gold | Peso | .365 | Gold: escudo ($1.825), doubloon ($3.650), and condor ($7.300). Silver: peso and divisions. |
| China | Silver | Tael. . . Amoy | .691 | |
| | | Canton | .689 | |
| | | Chefoo | .661 | |
| | | Chinkiang | .675 | |
| | | Fuchau | .639 | |
| | | Haikwan (Customs). | .703 | |
| | | Hankow | .647 | |
| | | Kiaochow | .682 | |
| | | Nankin | .684 | |
| | | Niuchwang | .648 | |
| | | Ningpo | .664 | |
| | | Pekin | .674 | |
| | | Shanghai | .631 | |
| | | Swatow | .638 | |
| | | Takau | .695 | |
| | | Tientsin | .670 | |
| | | Dollar. . . Hongkong | .455 | |
| | | British | .455 | |
| | | Mexican Chopped | .458 | |

VALUES OF FOREIGN COINS. Continued.

| COUNTRY. | Standard. | Monetary unit. | Value in terms of U. S. gold dollar. | Coins. |
|---|---|---|---|---|
| Colombia | Gold | Dollar | 1.000 | Gold: condor ($9.647) and double-condor. Silver: peso. |
| Denmark | Gold | Crown | .268 | Gold: 10 and 20 crowns. |
| Ecuador | Gold | Sucre | .487 | Gold: 10 sucres ($4.8665). Silver: sucre and divisions. |
| Egypt | Gold | Pound (100 piasters) | 4.943 | Gold: pound (100 piasters), 5, 10, 20, and 50 piasters. Silver: 1, 2, 5, 10, and 20 piasters. |
| Finland | Gold | Mark | .193 | Gold: 20 marks ($3.859), 10 marks ($1.93). |
| France | Gold | Franc | .193 | Gold: 5, 10, 20, 50, and 100 francs. Silver: 5 francs. |
| German Empire | Gold | Mark | .238 | Gold: 5, 10, and 20 marks. |
| Great Britain | Gold | Pound sterling | 4.866½ | Gold: sovereign (pound sterling) and ½ sovereign. |
| Greece | Gold | Drachma | .193 | Gold: 5, 10, 20, 50, and 100 drachmas. Silver: 5 drachmas. |
| Haiti | Gold | Gourde | .965 | Gold: 1, 2, 5, and 10 gourdes. Silver: gourde and divisions. |
| India | Gold | Pound sterling* | 4.866½ | Gold: sovereign (pound sterling). Silver: rupee and divisions. |
| Italy | Gold | Lira | .193 | Gold: 5, 10, 20, 50, and 100 lire. Silver: 5 lire. |
| Japan | Gold | Yen | .498 | Gold: 5, 10, and 20 yen. Silver: 10, 20, and 50 sen. |
| Liberia | Gold | Dollar | 1.000 | |
| Mexico | Gold | Peso† | .498 | Gold: 5 and 10 pesos. Silver: dollar‡ (or peso) and divisions. |
| Netherlands | Gold | Florin | .402 | Gold: 10 florins. Silver: ½, 1, and 2½ florins. |
| Newfoundland | Gold | Dollar | 1.014 | Gold: 2 dollars ($2.027). |
| Norway | Gold | Crown | .268 | Gold: 10 and 20 crowns. |
| Panama | Gold | Balboa | 1.000 | Gold: 1, 2½, 5, 10, and 20 balboas. Silver: peso and divisions. |
| Persia | Silver | Kran | .078 | Gold: ½, 1, and 2 tomans ($3.409). Silver: ¼, ½, 1, 2, and 5 krans. |
| Peru | Gold | Sol | .487 | Gold: libra ($4.8665). Silver: sol and divisions. |
| Philippine Islands | Gold | Peso | .500 | Silver peso: 10, 20, and 50 centavos. |
| Portugal | Gold | Milreis | 1.080 | Gold: 1, 2, 5, and 10 milreis. |
| Russia | Gold | Ruble | .515 | Gold: 5, 7½, 10, and 15 rubles. Silver: 5, 10, 15, 20, 25, 50, and 100 copecks. |
| Spain | Gold | Peseta | .193 | Gold: 25 pesetas. Silver: 5 pesetas. |
| Sweden | Gold | Crown | .268 | Gold: 10 and 20 crowns. |
| Switzerland | Gold | Franc | .193 | Gold: 5, 10, 20, 50, and 100 francs. Silver: 5 francs. |
| Turkey | Gold | Piaster | .044 | Gold: 25, 50, 100, 250, and 500 piasters. |
| Uruguay | Gold | Peso | 1.034 | Gold: peso. Silver: peso and divisions. |
| Venezuela | Gold | Bolivar | .193 | Gold: 5, 10, 20, 50, and 100 bolivars. Silver: 5 bolivars. |

NOTE—The coins of silver-standard countries are valued by their pure silver contents, at the average market price of silver for the three months preceding the date of this circular.

* The sovereign is the standard coin of India, but the rupee ($0.3244⅓) is the money of account, current at 15 to the sovereign.

† Seventy-five centigrams fine gold.

‡ Value in Mexico, $0.498.

## WORLD'S PRODUCTION OF GOLD AND SILVER FOR THE CALENDAR YEAR 1902.

Fine oz. of gold, $20.671834 +; fine oz. silver, $1.292929+, coining rate in U. S. silver dollars.

| Country. | Gold. | | Silver. | | |
|---|---|---|---|---|---|
| | Ounces (fine). | Value. | Ounces (fine). | Coining Value. | Commercial Value. |
| North America: | | | | | |
| United States | 3,870,000 | $80,000,000 | 55,500,000 | $71,757,600 | $29,415,000 |
| Mexico | 491,156 | 10,153,100 | 60,176,604 | 77,804,100 | 31,893,600 |
| Canada | 1,003,355 | 20,741,200 | 4,303,774 | 5,564,500 | 2,281,000 |
| Africa | 1,887,773 | 39,023,700 | ..... | ..... | ..... |
| Australasia | 3,946,374 | 81,578,800 | 8,026,037 | 10,377,100 | 4,253,800 |
| Europe: | | | | | |
| Russia | 1,090,053 | 22,533,400 | 158,679 | 205,200 | 84,100 |
| Austria-Hungary | 105,037 | 2 171,300 | 1,881,132 | 2,432,200 | 997,000 |
| Germany | 3,023 | 62,500 | 5,722,641 | 7,399,000 | 3,033,000 |
| Norway | 97 | 2,000 | 206,413 | 266,900 | 109,400 |
| Sweden | 3,023 | 62,500 | 46,226 | 59,800 | 24,500 |
| Italy | 257 | 5,300 | 964,339 | 1,246,800 | 511,100 |
| Spain | 494 | 10,200 | 3,700,189 | 4,784,100 | 1,961,100 |
| Portugal | 63 | 1,300 | 3,773 | 4,900 | 2,000 |
| Greece | ..... | ..... | 1,090,188 | 1,409,500 | 577,800 |
| Turkey | 1,480 | 30,600 | 480,566 | 621,300 | 254,700 |
| Finland | 63 | 1,300 | 8,679 | 11,200 | 4,600 |
| France | ..... | ..... | 384,339 | 496,900 | 203,700 |
| Great Britain | 5,626 | 116,300 | 173,208 | 223,900 | 91,800 |
| South America: | | | | | |
| Argentina | 1,451 | 30,000 | 37,720 | 48,800 | 20,000 |
| Bolivia | 228 | 4,700 | 12,992,641 | 16,798,600 | 6,886,100 |
| Chile | 27,825 | 575,200 | 3,566,792 | 4,611,600 | 1,890,400 |
| Colombia | 122,031 | 2,522,600 | 1,776,604 | 2,297,000 | 941,600 |
| Ecuador | 9,675 | 200,000 | 7,736 | 10,000 | 4,100 |
| Brazil | 96,488 | 1,994,600 | ..... | ..... | ..... |
| Venezuela | 20,985 | 433,800 | 1,887 | 2,400 | 1,000 |
| Guiana (British) | 87,491 | 1,808,600 | ..... | ..... | ..... |
| Guiana (Dutch) | 15,577 | 322,000 | ..... | ..... | ..... |
| Guiana (French) | 117,077 | 2,420,200 | ..... | ..... | ..... |
| Peru | 112,525 | 2,326,100 | 4,264,528 | 5,513,700 | 2,260,200 |
| Uruguay | 2,796 | 57,800 | 755 | 1,000 | 400 |
| Central America | 96,842 | 2,001,900 | 971,320 | 1,255,800 | 514,800 |
| Asia: | | | | | |
| Japan | 62,259 | 1,287,000 | 390,567 | 505,000 | 207,000 |
| China | 422,401 | 8,731,800 | ..... | ..... | ..... |
| Korea | 169,313 | 3,500,000 | ..... | ..... | ..... |
| India (British) | 463,824 | 9,588,100 | ..... | ..... | ..... |
| East Indies (British) | 49,686 | 1,027,100 | ..... | ..... | ..... |
| East Indies (Dutch) | 27,312 | 564,600 | 118,302 | 152,900 | 62,700 |
| Total | 14,313,660 | 295,889,600 | 166,955,639 | 215,861,800 | 88,486,500 |

"GOLD BRICKS," SPURIOUS IMITATIONS, SOLD TO THE UNWARY.

## COMPARATIVE VALUES OF ENGLISH AND UNITED STATES MONEY.

| d | $ | s | $ | s | $ | £ | $ |
|---|---|---|---|---|---|---|---|
| 1 | 0.02 | 1 | 0.24 | 12 | 2.92 | 1 | 4.87 |
| 2 | 0.04 | 2 | 0.49 | 13 | 3.17 | 2 | 9.74 |
| 3 | 0.06 | 3 | 0.73 | 14 | 3.41 | 3 | 14.61 |
| 4 | 0.08 | 4 | 0.97 | 15 | 3.65 | 4 | 19.48 |
| 5 | 0.10 | 5 | 1.22 | 16 | 3.90 | 5 | 24.35 |
| 6 | 0.12 | 6 | 1.46 | 17 | 4.14 | 6 | 29.22 |
| 7 | 0.14 | 7 | 1.71 | 18 | 4.38 | 7 | 34.09 |
| 8 | 0.16 | 8 | 1.95 | 19 | 4.63 | 8 | 38.96 |
| 9 | 0.18 | 9 | 2.19 | ..... | ..... | 9 | 43.83 |
| 10 | 0.20 | 10 | 2.44 | ..... | ..... | 10 | 48.87 |
| 11 | 0.22 | 11 | 2.68 | | | | |

## HEIGHT OF OFFICE BUILDINGS.

| Building. | Total height from sidewalk, ft. |
|---|---|
| Park Row Building, New York.. | 386 |
| Times Building, New York ..... | 363 |
| Manhattan Life Bldg., N. Y..... | 348 |
| Wall St. Exchange Bldg., N. Y.. | 341 |
| St. Paul Building, New York.... | 313 |
| American Surety Bldg., N. Y... | 312 |
| Pulitzer (World) Bldg., N. Y.... | 309 |
| Broad-Exchange Bldg., N. Y... | 280 |
| 42 Broadway Bldg., New York.. | 260 |
| Whitehall Bldg., New York..... | 257 |
| Bowling Green Bldg., N. Y..... | 224 |

## DIMENSIONS OF THE PRINCIPAL DOMES.

| | Diam. ft. | Height. ft. |
|---|---|---|
| Pantheon, Rome..... | 142 | 143 |
| Cathedral, Florence..... | 139 | 310 |
| St. Peter's, Rome..... | 139 | 330 |
| Capitol, Washington, D. C... | 135½ | 287½ |
| St. Sophia, Constantinople... | 115 | 201 |
| Baths of Caracalla, (Ancient) Rome..... | 112 | 116 |
| St. Paul's, London..... | 112 | 215 |

## TUNNELS OF THE WORLD.

| | Miles. | Under. |
|---|---|---|
| New York Subway (1904)* | 23 | City. |
| London Metropolitan..... | 13 | City. |
| Simplon, Switzerland..... | 12 | Mountain. |
| St. Gothard..... | 9 | Mountain. |
| Paris Underground (incomplete)..... | 8½ | City. |
| Mount Cenis, Switzerland.... | 7½ | Mountain. |
| B. & O. Tunnel, Baltimore .. | 7 | City. |
| Arlberg, Austria..... | 6 | Mountain. |
| "Tube" London..... | 6 | City. |
| Hoosac Tunnel, Mass..... | 4½ | Mountain. |
| Berlin, Underground..... | 4½ | City. |
| Liverpool-Birkenhead..... | 4½ | City and Mersey River. |
| Boston, Mass., Subway..... | 2½ | City. |

* Other subways, tunnels, and spurs are in progress.

STRIKING THE IMPRESSION ON A GOLD PIECE AT THE MINT.

## HEIGHT OF COLUMNS, SPIRES AND TOWERS.

| | Feet. |
|---|---|
| Eiffel Tower, Paris | 1,000 |
| Washington Monument, Washington, D.C. | 555 |
| Pyramid of Cheops | 520 |
| St. Peter's, Rome | 518 |
| Cologne Cathedral | 501 |
| Strasburg | 486 |
| Cathedral, Antwerp | 476 |
| St. Stephen's, Vienna | 465 |
| Cathedral, Salisbury | 450 |
| Milan Cathedral | 360 |
| Cathedral, Cremona | 397 |
| St. Peter's, Rome | 391 |
| Cathedral, Florence | 352 |
| St. Paul's, London | 366 |
| Hôtel des Invalides, Paris | 344 |
| Bunker Hill Monum't, Charlestown, Mass. | 221 |
| Leaning Tower of Pisa | 179 |
| Alexander Column, St. Petersburg | 175 |

## THE WEIGHT OF BELLS.

| | Pounds |
|---|---|
| Kremlin, Moscow | 432,000 |
| Pekin | 130,000 |
| St. Ivan's, Moscow | 127,800 |
| Novgorod | 62,000 |
| Sacred Heart, Paris | 55,116 |
| Sens | 43,000 |
| Vienna | 40,200 |
| Olmutz, Bohemia | 40,000 |
| Rouen | 40,000 |
| Erfurt | 30,800 |
| Westminster, "Big Ben" | 30,300 |
| Houses of Parliament, London | 30,000 |
| Notre Dame, Paris | 28,600 |
| Montreal | 28,500 |
| Cologne | 25,000 |
| City Hall, N. Y. | 22,500 |

## LENGTH OF A FEW CELEBRATED BRIDGES.

| Name. | Length ft. | Type. | Spanning. |
|---|---|---|---|
| Firth of Tay, Scotland | 10,779 | Girder. | Firth of Tay. |
| Forth, Scotland | 8,296 | Cantilever. | Firth of Forth. |
| East River, New York | 7,200 | Suspension. | East River. |
| Brooklyn, New York | 5,989 | Suspension. | East River. |
| Manhattan, New York | 9,900 | Suspension. | East River. |
| Blackwell's Island, New York | 7,450 | Cantilever. | East River. |
| Washington Bridge, New York | 2,300 | Composite. | Harlem River. |
| High Bridge, New York | 1,460 | Stone. | Harlem River. |
| Niagara, below Falls, New York | 1,040 | Suspension. | Niagara River. |
| Niagara | 910 | Cantilever. | Niagara River. |
| Freiburg, Germany | 880 | Suspension. | ——— |
| Clifton, England | 702 | Suspension. | Avon. |
| Buda-Pest, Hungary | 666 | Suspension. | Danube. |

$50,000,000 IN GOLD BARS AT THE U. S. MINT IN PHILADELPHIA.

## BALLOONS.

In *aërostation*, a bag or hollow pear-shaped vessel, made of varnished silk or other light material, and inflated with some gas or vapor lighter than the air, as hydrogen, carbureted hydrogen, heated air, etc., so as to rise and float in the atmosphere. When filled with gas it is called by way of distinction an AIR-BALLOON (*aërostat*, etc., Fr.; *luftball*, *luft-schiff*, etc., Ger.); when with heated air a FIRE-BALLOON or MONTGOLFIER B. (*balloon à feu*, etc., Fr.).

In the early days of aërostation, and indeed for some years afterwards, balloons were inflated with hydrogen gas, obtained by the action of sulphuric acid and water on iron filings or small fragments of iron; but this method of filling them ultimately gave place to the cheaper and more convenient supply afforded by the gas-light companies. Of late years, the coal-gas furnished by the gas-works has been generally, if not solely, used for the inflation of balloons.

The principles of ballooning may be referred to the well-known difference in the specific gravity of bodies, and to the physical properties of the atmosphere. Pure hydrogen, weighed at the level of the sea, is about 14½ times lighter than common air; but when prepared on the large scale, and containing water and other impurities, it is only from 7 to 11 times lighter than the atmosphere. A globe of atmospheric air 1 foot in diameter, under like circumstances, weighs 1·25 lb.; a similar globe of hydrogen (reckoning it only as 6 times lighter than common air), will, therefore, have an ascensional force of 1·30 lb. Now the weight of the body of air which a balloon displaces must exceed the gross weight of the balloon and all its appendages, in order for the latter to ascend in the atmosphere. The difference of the two weights expresses the ascensional force. The aërostatic power of balloons is proportional to their dimensions, in the ratio of the cubes of their diameters. Thus, it appears that a balloon of 60 feet diameter filled with common hydrogen will ascend with a weight of nearly 7,000 lbs., besides the gas case; whilst one of only 1½ feet in diameter will barely float, owing to the less proportionate volume of gas to the weight of the case containing it. In round numbers the buoyancy of a balloon may be reckoned as equal to 1 oz. for every cubic foot of hydrogen it contains, less the weight of the case and appendages. The carbureted hydrogen supplied by the gas-works is much heavier than hydrogen gas, and consequently much less buoyant, for which due allowance must be made. That which possesses the least illuminating power is the lightest, and consequently the best adapted for aërostation.

The fabric of which the cases of air-balloons are made is strong thin silk, covered with an elastic varnish of drying oil or india-rubber, or, what is better, a solution of india-rubber in either chloroform or bisulphide of carbon; the netting is of strong light silk or flaxen cord; and the car, of basket-work. Fire-balloons, on the small scale, are generally made of silver-paper, and are inflated with the fumes of burning alcohol by means of a sponge dipped in that liquid, and suspended just within the mouth of the apparatus.

The following table will prove useful to the amateur aëronaut or balloonist:

TABLE SHOWING THE RELATIONS BETWEEN THE DIAMETERS, SURFACES, AND CAPACITIES OF SPHERES.

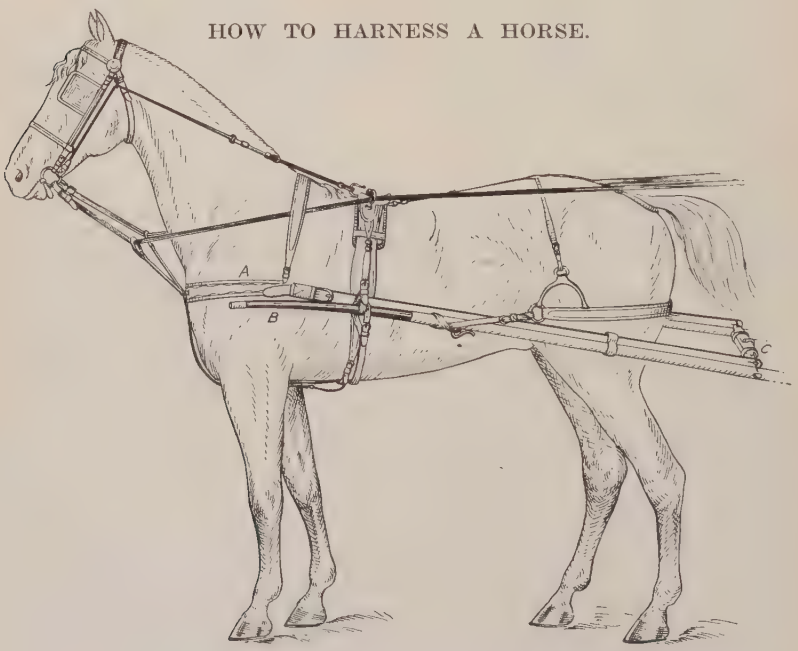
| Diameters. | Surfaces. | Cubical content |
|---|---|---|
| 1 | 3.141 | .523 |
| 2 | 12.567 | 4.188 |
| 3 | 28.274 | 14.137 |
| 4 | 50.265 | 33.51 |
| 5 | 78.54 | 65.45 |
| 10 | 314.159 | 523.6 |
| 15 | 706.9 | 1767.1 |
| 20 | 1256.6 | 4189 |
| 25 | 1963.5 | 8181 |
| 30 | 2827 | 14137 |
| 40 | 5026 | 33510 |

Owing to the increasing rarity of the atmosphere as we ascend from the earth's surface, balloon cases are made very much larger than is required to contain the necessary quantity of gas, to allow for its expansion as it rises into a rarer medium. A cubical foot of gas measured at the level of the sea, occupies a space of two feet at an elevation of 3½ miles.—Cooley's Cyclopedia.

## AERIAL NAVIGATION.

No motive power machine sufficiently light and powerful to lift itself from the ground and maintain itself in the air for any considerable time has yet been invented. Aerial navigation is therefore at present limited to the use of balloons filled with light gas or hot air. Common coal gas is found to be the cheapest and most generally available gas for ballooning. 1,000 cubic feet of coal gas will lift 35 pounds weight. But hydrogen is the best gas for the purpose. 1,000 cubic feet of hydrogen gas will lift from 60 to 70 pounds. It is the lightest of all substances. It is fifteen times lighter than air, and over eleven thousand times lighter than water. One of the cheapest ways to make hydrogen for balloons is to dissolve zinc in sulphuric acid; the latter is composed of sulphur and hydrogen. When the acid is poured on zinc, the sulphur unites with the metal and sets free the hydrogen, which bubbles up, and is conducted in a pipe to the balloon. Various efforts to propel and steer balloons have been made, by means of propellers turned by hand; also by the use of the electrical storage battery. Balloons are generally made of cotton cloth or silk, varnished with linseed oil, and dissolved rubber is sometimes mixed with the oil.

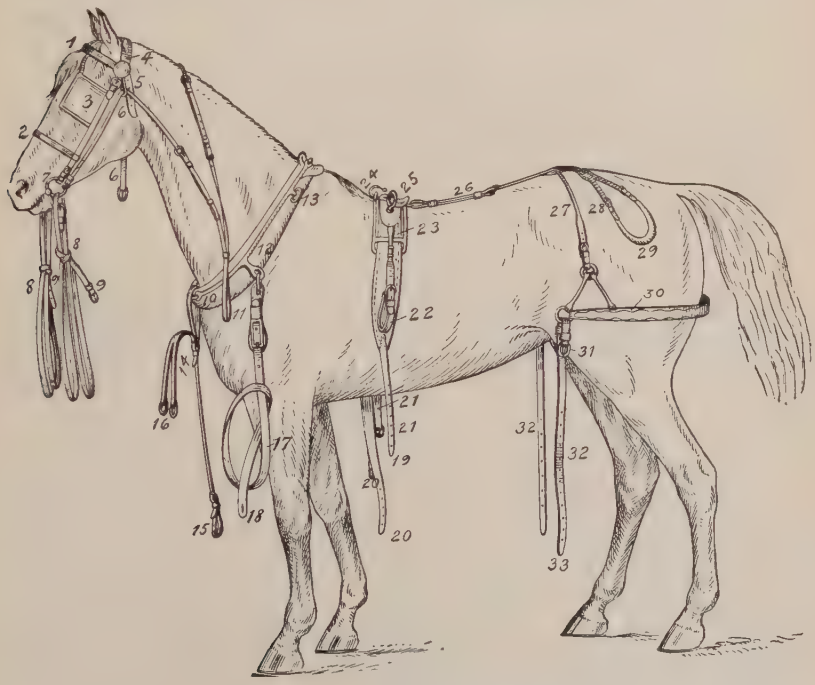
## HOW TO HARNESS A HORSE.




Every one should know how to harness a horse, and our second engraving shows the harness placed on a horse with the buckles unfastened and an English collar. The first engraving shows the harness fastened to the shaft and a Dutch collar in place of the English collar. If a Dutch collar is used, slip this over the horse's head, then put on the rest of the harness. If an English collar is used, reverse the collar so that the wide part will be uppermost, and force it over the horse's head, slipping it over the ears, then at the narrow part of the horse's neck turn the collar around so that the narrow part will be uppermost and slip it back on to the horse's shoulders.

If the hames are too tight to allow the collar to slip over the ears, unfasten the hames, and after the collar is on, buckle them once more in front. Next, put on the saddle and breeching, slipping the crupper over the horse's tail by doubling the hair of the tail with the right hand and slipping the crupper over the bunch thus formed, drawing out the hair completely through the crupper. Fasten the inner belly band, first passing it through the loop of the collar strap No. 15 or the martingale, and then pushing the saddle forward as far as the crupper will allow it to go.

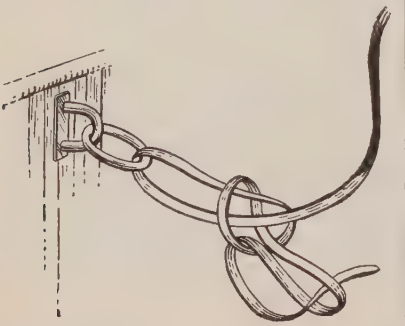
The time has now arrived to bridle the horse. The halter being removed, the horse's head is taken by the forelock with three fingers of the right hand, leaving the forefinger and thumb free, and holding the bridle in the left hand. Pass the head piece of the bridle to the thumb and forefinger of the right hand and slip the bit into the horse's mouth with the left hand, which is then raised to assist the right hand in pulling the head piece back over the horse's ears. Should there be any difficulty in making the horse open his mouth, the bit should be held to his teeth while dangling from the right hand, and then with the thumb and second finger of the left hand press the gums of the horse's mouth at the junction of the lips gently against the teeth. This will quickly force any horse to open his mouth. When the bit is in place, the throat strap is buckled. If a curb bit is used, the



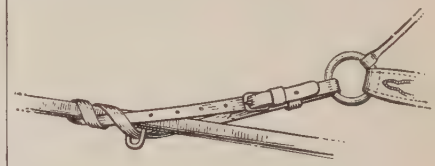

A HORSE HARNESSED WITH THE BUCKLES UNFASTENED.

1, is the brow band; 2, nose band; 3, blinders; 4, head band; 5 and 6, throat strap; 7, bit; 8 and 9, reins; 10, hame fastener; 11, check rein; 12, collar; 13, terrets; 14 and 15, collar straps; 16, martingale; 17 and 18, traces; 19, inner bellyband; 20, outer bellyband; 21, part of inner bellyband; 22, shaft loops; 23, saddle; 24, check-rein hook; 25, saddle terrets; 26, crupper strap; 27, breeching strap; 28 and 29, crupper; 30, breeching; 31 32, and 33, hold-back straps.

curb chain must be twisted until it becomes flat, and then hooked, passing under the jaw of the horse to the curb chain hook in the opposite side



of the bit. The reins are now buckled in the slots at the curb next below the bit ring. Lift up the shafts above the horse's back, then draw up the carriage, slipping the ends of the shafts through the shaft tugs on the sides of



the saddle. The traces are then run through the loop at the side of the shafts and secured to the trace hooks on each side of the whiffletree. After the traces are taut, fasten the breeching or hold-back straps.

## PASSPORTS.

Passports are granted and issued by the Secretary of State and by diplomatic representatives of the United States and foreign countries, or by United States Consuls. The fee is $1, and the necessary blank and full information as to the procedure required will be sent on request. Address the Secretary of State, Washington, D. C.

## ACCIDENTS IN FACTORIES.

The Annual Report of the Bureau of Labor Statistics of the State of New York for 1899 gives some interesting figures. In April, May, June, 1899, the figures (New York State) are as follows:

ACCIDENTS IN APRIL, MAY, JUNE, 1899.

| INDUSTRIES. | Firms Reporting. | | Establishments in which accid'ts occurred. | Injuries. | | |
|---|---|---|---|---|---|---|
| | Establishments. | Employees Jun.30 | | Employees injured in this period. | Proportionate number in one year. | Per ann'm in each 1,000 employed. |
| Stone and clay products | 277 | 19,764 | 39 | 75 | 300 | 15.18 |
| Metals, machinery, apparatus | 1,321 | 123,467 | 260 | 817 | 3,268 | 26.47 |
| Wood | 536 | 31,482 | 84 | 145 | 580 | 18.42 |
| Leather, rubber, pearl, etc | 343 | 31,169 | 20 | 25 | 100 | 3.21 |
| Chemicals, oils, explosives | 163 | 13,164 | 32 | 145 | 580 | 44.06 |
| Pulp, paper, etc | 105 | 8,201 | 27 | 87 | 348 | 42.43 |
| Printing | 576 | 38,293 | 58 | 88 | 352 | 9.19 |
| Textiles | 327 | 59,709 | 53 | 135 | 540 | 9.04 |
| Clothing, millinery, laundering | 514 | 65,220 | 16 | 22 | 88 | 1.35 |
| Food, tobacco, liquors | 474 | 45,600 | 66 | 178 | 712 | 15.61 |
| Distribution of water, gas, electricity | 26 | 7,043 | 11 | 69 | 276 | 37.28 |
| Building industry | 269 | 9,313 | 25 | 61 | 244 | 26.20 |
| Total | 4,931 | 452,425 | 691 | 1,847 | 7,388 | 16.33 |

## CAUSE OR AGENT OF ACCIDENTS IN NEW YORK.

| | |
|---|---|
| Machinery. | |
| Engines, power transmission, belts, etc. | 46 |
| Lifting apparatus | 50 |
| Circular saws | 102 |
| Presses and stamping machines | 135 |
| Other machines and machine tools | 319 |
| Total—Machinery | 652 |
| Hand tools (saws, axes, etc.) | 110 |
| Explosives of all kinds | 26 |
| Hot liquids, steam, acids, etc | 115 |
| Fall of objects, collapse of structures, etc. | 374 |
| Fall of the person | 197 |
| Loading, unloading, etc., by hand | 54 |
| Vehicles and animals | 71 |
| All other | 193 |
| Grand Total | 1,792 |
| Cause not reported | 55 |

## PERIOD OF DISABILITY.

| | | |
|---|---|---|
| Not over one week: | | |
| Less than one day | 45 | |
| One day | 85 | |
| From 2 to 7 days | 492 | |
| | | 622 |
| From one week to one month: | | |
| Over 1 to 2 weeks | 292 | |
| Over 2 to 3 weeks | 169 | |
| Over 3 to 4 weeks | 95 | |
| | | 556 |
| Over 1 month to 2 months | | 128 |
| Over 2 months (but less than 3 months) | | 42 |
| Total | | 1,348 |
| Total days lost | 19,980 | |
| Average days lost per capita | 15 | |
| Still disabled at time of report (June 30) | | 27 |
| No time lost (i.e. less than one hour) | | 161 |
| Time lost not reported | | 282 |
| Fatal accidents | | 29 |
| Total | | 1,847 |

## NATURE OF INJURIES.

| | |
|---|---|
| Fatal | 29 |
| Non-fatal: | |
| Internal | 29 |
| Loss of eye | 8 |
| Head and face, except the eye | 191 |
| Loss of limb | 3 |
| Arms and hands | 336 |
| Fingers | 638 |
| Legs and feet | 381 |
| Other parts of the body or several parts at once | 197 |
| Not reported | 35 |
| Total | 1,847 |

## FATAL ACCIDENTS IN VARIOUS OCCUPATIONS.

| | Period. | Rate per 1,000 |
|---|---|---|
| Railroad brakemen | 1900–02 | 15.8 |
| Gloucester fishermen | 1892–00 | 13.2 |
| Gunpowder manufacture | ....–00 | 10.5 |
| Railroad switchmen and flagmen | 1900–02 | 7.2 |
| Railroad firemen | 1900–02 | 7.2 |
| Railroad engineers | 1900–02 | 6.8 |
| Dynamite manufacturers | ....–00 | 6.7 |
| Railroad conductors | 1900–02 | 6.1 |
| Anthracite coal miners | 1892–01 | 5.6 |
| Bituminous mine laborers | 1892–01 | 4.7 |
| Anthracite mine laborers | 1892–01 | 4.6 |
| Lead and zinc miners of Missouri | 1892–01 | 3.3 |
| Metal miners of Colorado | 1896–01 | 3.2 |
| Copper miners of Montana | 1891–00 | 2.8 |
| Anthracite fire-bosses | 1892–01 | 2.5 |
| Paid firemen in cities | 1885–00 | 2.5 |
| Bituminous coal miners | 1892–01 | 2.2 |

It is shown by this table that railroad brakemen have the highest fatal accident figure, being respectively 15.8 per 1,000.—*Engineering and Mining Journal.*

## ANNUAL FIRE LOSSES IN THE UNITED STATES FOR FOURTEEN YEARS—1890–1903—CHRONICLE FIRE TABLES.

| Years. | Aggregate Property Loss. | Aggregate Insurance Loss. | Years. | Aggregate Property Loss. | Aggregate Insurance Loss. |
|---|---|---|---|---|---|
| 1890 | $108,993,792 | $65,015,465 | 1897 | $116,354,575 | $66,722,145 |
| 1891 | 143,764,967 | 90,576,918 | 1898 | 130,593,905 | 73,796,080 |
| 1892 | 151,516,098 | 93,511,936 | 1899 | 153,597,830 | 92,683,715 |
| 1893 | 167,544,370 | 105,994,577 | 1900 | 160,929 805 | 95,403,650 |
| 1894 | 140,006,484 | 89,574,699 | 1901 | 165,817,810 | 100,798,645 |
| 1895 | 142,110,233 | 84,689,030 | 1902 | 161,078,040 | 94,460,525 |
| 1896 | 118,737,420 | 73,903,800 | 1903 | 145,302,155 | |

| | |
|---|---|
| Total property loss in the United States in 14 years | $3,371,912,031 |
| Total insurance loss in the United States in 14 years | 1,988,644,949 |
| Total property loss, United States and Canada, Jan. 1, 1904, to Sept. 1, 1904 | 194,172,850 |

## WHAT TO DO IN CASE OF FIRE.

BY CHIEF EDWARD F. CROKER OF THE NEW YORK FIRE DEPARTMENT.

In case of fire immediately send alarm from the nearest alarm box; wait at alarm box until the arrival of the firemen so as to notify them as to the location of the fire. Occupants of premises should endeavor to extinguish fire, if possible, previous to the arrival of the firemen, but do not delay an instant in sending in alarm. Keep cellars and closets under stairways entirely free from rubbish. Always endeavor to keep perfectly cool until the arrival of the Department; do not jump, as the firemen will save you, and are very prompt in reaching the scene of a fire once the alarm is turned in. Keep small chemical fire extinguishers on each floor in all buildings. In case of fire, endeavor to keep all doors shut, thereby avoiding draughts and preventing the rapid extending of fire.

## THE COST OF LIVING.

| July 1. | Breadstuffs. | Meats. | Dairy and Garden. | Other Food. | Clothing. | Metals. | Miscellaneous. | Total. |
|---|---|---|---|---|---|---|---|---|
| 1861 | 15.749 | 7.485 | 10.813 | 7.653 | 21.147 | 22.500 | 16.573 | 101.920 |
| 1862 | 18.057 | 7.150 | 13.406 | 10.987 | 28.413 | 23.207 | 17.290 | 118.510 |
| 1863 | 26.154 | 10.115 | 13.530 | 16.359 | 45.679 | 37.079 | 24.264 | 173.180 |
| 1864 | 45.616 | 15.685 | 26.053 | 27.303 | 73.485 | 59.192 | 31.653 | 278.987 |
| 1865 | 25.404 | 16.112 | 18.049 | 21.057 | 49.307 | 38.956 | 25.551 | 194.436 |
| 1866 | 31.471 | 17.153 | 23.472 | 20.821 | 45.377 | 41.762 | 27.922 | 207.978 |
| 1867 | 36.537 | 14.278 | 18.418 | 20.167 | 38.169 | 35.426 | 25.529 | 188.524 |
| 1868 | 38.416 | 13.210 | 23.614 | 19.720 | 35.694 | 27.385 | 24.786 | 182.825 |
| 1869 | 29.116 | 13.181 | 18.121 | 16.347 | 35.309 | 28.355 | 24.201 | 164.630 |
| 1870 | 25.322 | 14.161 | 16.112 | 13.308 | 31.480 | 26.612 | 21.786 | 148.781 |
| 1871 | 24.809 | 12.177 | 20.799 | 13.823 | 30.624 | 27.371 | 21.907 | 151.510 |
| 1872 | 22.171 | 11.055 | 16.019 | 14.845 | 32.427 | 32.643 | 21.319 | 150.479 |
| 1873 | 20.460 | 10.114 | 15.629 | 13.625 | 29.411 | 32.298 | 21.552 | 143.089 |
| 1874 | 25.657 | 11.560 | 19.142 | 13.678 | 27.260 | 25.254 | 19.582 | 143.133 |
| 1875 | 24.848 | 13.287 | 14.918 | 14.418 | 25.318 | 23.515 | 18.398 | 134.702 |
| 1876 | 18.777 | 10.726 | 15.912 | 12.914 | 21.747 | 20.452 | 15.951 | 116.479 |
| 1877 | 21.812 | 10.036 | 11.790 | 13.321 | 21.850 | 15.578 | 15.160 | 109.547 |
| 1878 | 15.672 | 8.181 | 10.608 | 11.346 | 19.836 | 15.789 | 14.836 | 96.268 |
| 1879 | 17.054 | 8.239 | 10.253 | 9.884 | 20.420 | 15.149 | 16.286 | 97.285 |
| 1880 | 17.461 | 9.230 | 12.594 | 11.539 | 21.984 | 18.708 | 17.139 | 108.655 |
| 1881 | 20.369 | 11.381 | 11.311 | 11.663 | 20.982 | 19.295 | 16.900 | 111.901 |
| 1882 | 25.494 | 13.740 | 14.685 | 11.627 | 21.202 | 19.832 | 16.650 | 123.230 |
| 1883 | 19.018 | 11.210 | 12.250 | 10.726 | 20.209 | 18.071 | 15.764 | 107.248 |
| 1884 | 17.871 | 11.172 | 11.369 | 9.323 | 19.014 | 16.272 | 14.685 | 99.706 |
| 1885 | 16.370 | 9.205 | 10.872 | 8.712 | 17.740 | 14.132 | 13.666 | 90.697 |
| 1886 | 15.311 | 8.906 | 10.241 | 8.570 | 18.063 | 14.466 | 13.669 | 89.226 |
| 1887 | 15.156 | 8.667 | 11.188 | 9.252 | 18.174 | 16.035 | 15.153 | 93.624 |
| 1888 | 16.984 | 9.416 | 11.849 | 9.917 | 17.447 | 15.366 | 14.155 | 95.134 |
| 1889 | 14.351 | 8.244 | 9.695 | 10.912 | 17.107 | 14.782 | 14.600 | 89.691 |
| 1890 | 14.867 | 8.036 | 10.711 | 9.749 | 17.264 | 15.506 | 15.416 | 91.549 |
| 1891 | 19.782 | 9.217 | 12.455 | 9.339 | 16.501 | 15.107 | 13.691 | 96.092 |
| 1892 | 17.426 | 8.700 | 10.403 | 8.733 | 15.648 | 14.827 | 14.252 | 90.105 |
| 1893 | 14.963 | 10.135 | 11.710 | 9.188 | 15.871 | 14.030 | 14.716 | 90.613 |
| 1894 | 15.115 | 9.389 | 10.394 | 8.478 | 13.860 | 12.015 | 14.041 | 83.292 |
| 1895 | 14.765 | 8.622 | 9.874 | 8.689 | 15.315 | 11.021 | 13.233 | 81.519 |
| 1896 | 10.504 | 7.058 | 7.872 | 8.529 | 13.602 | 13.232 | 13.520 | 74.317 |
| 1897 | 10.587 | 7.529 | 8.714 | 7.887 | 13.808 | 11.642 | 12.288 | 72.455 |
| 1898 | 12.783 | 7.694 | 9.437 | 8.826 | 14.663 | 11.843 | 12.522 | 77.768 |
| 1899 | 13.483 | 7.988 | 10.974 | 9.157 | 15.021 | 15.635 | 12.969 | 85.227 |
| 1900 | 14.898 | 8.906 | 10.901 | 9.482 | 16.324 | 14.834 | 16.070 | 91.415 |
| 1901 | 14.904 | 9.430 | 11.030 | 9.086 | 15.098 | 15.344 | 16.617 | 91.509 |
| 1902 | 20.534 | 11.628 | 12.557 | 8.748 | 15.533 | 16.084 | 16.826 | 101.910 |
| 1903 | 17.473 | 9.269 | 13.083 | 9.186 | 17.136 | 16.544 | 16.765 | 99.456 |
| 1904 | 18.244 | 9.033 | 10.648 | 10.406 | 16.514 | 15.428 | 16.919 | 97.192 |
| 1905 | 18.831 | 8.614 | 9.982 | 9.922 | 17.986 | 15.916 | 17.061 | 98.312 |

NOTE.—Breadstuffs include many quotations of wheat, corn, oats, rye, and barley, besides beans and peas; meats include live hogs, beef, sheep, and many provisions, lard, tallow, etc.; dairy and garden products include eggs, vegetables and fruits; other foods include fish, liquors, condiments, sugar, rice, tobacco, etc.; clothing, includes the raw material of each industry, and many quotations of woolen, cotton and other textile goods, as well as hides, leather, boots and shoes; metals include various quotations of pig iron, and partially manufactured and finished products, as well as minor metals, coal, and petroleum. The miscellaneous class embraces many grades of hard and soft lumber, lath, brick, lime, glass, turpentine, hemp, linseed-oil, paints, fertilizers, and drugs.—*Dun's Review.*

## DISTILLED SPIRITS, WINES, AND MALT LIQUORS, QUANTITIES CONSUMED.

### CONSUMPTION PER CAPITA IN THE UNITED STATES.

| Year Ending June 30— | Distilled Spirits Consumed. | | | | Wines Consumed. | | | Malt Liquors Consumed. | | | Total Consumption of Wines and Liquors. | Total Consumption per Capita. | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Domestic.[1] | | Imported for Consumption. | Total. | Domestic.[2] | Imported for Consumption. | Total | Domestic.[2] | Imported for Consumption. | Total. | | Of Distilled Spirits. | Of Wines. | Of Malt Liquors. | Of all Liquors and wines |
| | From Fruit. | All Other. | | | | | | | | | | | | | |
| | Proof Gallons. | Proof Gallons. | Proof Gallons. | Proof Gallons. | Proof Gallons. | Gallons. | Gallons. | Gallons. | Gallons. | Gallons. | Gallons. | Gallons. | Gallons. | Gallons. | Gallons. |
| 1881 | 1,701,206 | 67,426,000 | 1,479,875 | 70,607,081 | 18,931,819 | 5,231,106 | 24,162,925 | 442,947,604 | 1,164,505 | 444,112,109 | 538,882,175 | 1.38 | 0.47 | 8.65 | 10.50 |
| 1890 | 1,508,130 | 84,760,240 | 1,561,192 | 87,829,562 | 23,896,108 | 5,060,873 | 28,956,981 | 853,075,734 | 2,716,601 | 855,792,335 | 972,578,878 | 1.40 | .46 | 13.07 | 15.53 |
| 1900 | 1,386,361 | 94,156,023 | 1,705,998 | 97,248,382 | 26,492,491 | 3,935,000 | 30,427,491 | 1,218,183,252 | 3,316,908 | 1,221,500,160 | 1,349,176,033 | 1.27 | .40 | 16.01 | 17.68 |
| 1904 | 1,637,303 | 116,808,978 | 2,655,716 | 121,101,997 | 37,538,799 | 5,517,568 | 43,316,636 | 1,489,354,250 | 4,837,075 | 1,494,191,325 | 1,658,609,958 | 1.48 | .53 | 18.28 | 20.29 |

[1] Since 1885 includes domestic spirits exported and returned. [2] Product less domestic exports.

## RELIGIONS OF THE WORLD.

| | |
|---|---|
| Roman Catholics | 216,000,000 |
| Protestants | 137,000,000 |
| Greek, Armenian and Abyssinian Churches | 95,000,000 |
| Total of Christians | 448,000,000 |
| Buddhists and Brahmins | 672,000,000 |
| Mohammedans | 200,000,000 |
| Jews | 7,000,000 |
| Other creeds | 125,000,000 |
| Total non-Christians | 1,004,000,000 |

## THE CHRISTIAN ADVOCATE'S TABLE OF DENOMINATIONS.

| Denominations. | Summary for 1903. Ministers. | Churches. | Communicants. |
|---|---|---|---|
| Adventists (6 bodies) | 1,556 | 2,377 | 89,476 |
| Baptists (13 bodies) | 35,829 | 51,492 | 4,725,775 |
| Brethren (River) (3 bodies) | 151 | 108 | 3,605 |
| Brethren (Plymouth) (4 bodies) | ..... | 314 | 6,661 |
| Catholics (8 bodies) | 13,422 | 11,185 | 9,891,869 |
| Catholic Apostolic | 95 | 10 | 1,491 |
| Chinese Temples | ..... | 47 | ..... |
| Christadelphians | ..... | 63 | 1,277 |
| Christian Connection | 1,348 | 1,340 | 101,597 |
| Christian Catholics (Dowie) | 104 | 110 | 40,000 |
| Christian Missionary Association | 10 | 13 | 754 |
| Christian Scientists | 1,118 | 559 | 60,283 |
| Church of God (Winebrennarian) | 460 | 580 | 38,000 |
| Church of the New Jerusalem | 143 | 144 | 7,969 |
| Communistic Societies (6 bodies) | ..... | 22 | 3,084 |
| Congregationalists | 6,213 | 5,891 | 659,704 |
| Disciples of Christ | 6,567 | 11,157 | 1,235,798 |
| Dunkards (4 bodies) | 3,231 | 1,171 | 115,194 |
| Evangelical (2 bodies) | 1,415 | 2,642 | 162,998 |
| Friends (4 bodies) | 1,354 | 1,093 | 116,555 |
| Friends of the Temple | 4 | 4 | 340 |
| German Evangelical Protestant | 100 | 155 | 20,000 |
| German Evangelical Synod | 945 | 1,213 | 209,791 |
| Jews (2 bodies) | 301 | 570 | 143,000 |
| Latter-Day Saints (2 bodies) | 1,525 | 1,324 | 342,072 |
| Lutherans (22 bodies) | 7,343 | 12,275 | 1,715,910 |
| Swedish Evangelical Miss. Covenant | 291 | 307 | 33,400 |
| Mennonites (12 bodies) | 1,138 | 673 | 59,892 |
| Methodists (17 bodies) | 39,634 | 57,572 | 6,192,494 |
| Moravians | 127 | 115 | 16,095 |
| Presbyterians (12 bodies) | 12,393 | 15,452 | 1,661,522 |
| Protestant Episcopal (2 bodies) | 5,150 | 6,867 | 782,543 |
| Reformed (3 bodies) | 1,919 | 2,491 | 390,578 |
| Salvation Army | 2,361 | 696 | 25,009 |
| Schwenkfeldians | 3 | 4 | 306 |
| Social Brethren | 17 | 20 | 913 |
| Society for Ethical Culture | ..... | 4 | 1,500 |
| Spiritualists | ..... | 334 | 45,030 |
| Theosophical Society | ..... | 70 | 1,900 |
| United Brethren (2 bodies) | 2,368 | 4,861 | 280,114 |
| Unitarians | 540 | 452 | 71,000 |
| Universalists | 734 | 786 | 53,538 |
| Independent Congregations | 54 | 156 | 14,126 |
| Grand total in 1903 | 149,963 | 196,719 | 29,323,158 |
| Grand total in 1902 | 147,732 | 194,072 | 28,840,699 |

# PART II.

# CHAPTER I.

## GEOMETRICAL CONSTRUCTIONS.

### GEOMETRICAL FIGURES.

1. Acute Angle.—An acute angle is less than a right angle, or less than 90 degrees.

2. Alternate Angles.—The internal angles made by two lines with a third, on opposite sides of it. If the two lines are parallel, the alternate angles are equal. If the parallels *AB*, *CD*, be cut by the line *EF*, the angles *AGH*, *GHD*, as also the angles *BGH* and *GHC*, are called alternate angles.

3. Arc.—Any part of the circumference of a circle or other curve; a segment of a circle.

4, 5, 6, and 7. Conic Sections.—Formed by the intersections of cones and planes. The conic sections are the ellipse, parabola, and hyperbola. If the section be taken parallel to the base of the cone its outline will form a perfect circle. If the section be taken parallel to one side of the cone it will in outline have the form of a parabola (6). If the section be taken parallel to the axis of the cone its outline will have the form of a hyperbola (7). Any other section through the cone will in outline have the form of an ellipse (5).

8. Chord.—A right line marking the extremities of the arc of a circle.

9. Circle.—1. In geometry, a plane figure, comprehended by a single curve line, called its circumference, every part of which is equally distant from a point called the center. Of course all lines drawn from the center to the circumference, or periphery, are equal to each other. 2. In popular use, the line that comprehends the figure, the plane or surface comprehended, and the whole body or solid matter of a round substance, are denominated a circle; a ring; an orb; the earth.

10. Curve.—A curve line is one which may be cut by a right line in more points than one. A curve line is that which is neither a straight line nor composed of straight lines.

11. Cube.—A regular, solid body with six equal square sides.

12. Cylinder.—A solid body supposed to be generated by the rotation of a parallelogram round one of its sides; or a long, circular body, of uniform diameter, and its extremities forming equal parallel circles.

13. Diagonal.—The line extending from one angle to another of a quadrilateral or multilateral figure, and dividing it into two parts.

14. Diagram.—A figure, draught, or scheme delineated for the purpose of demonstrating the properties of any figure, as a square, triangle, circle, etc.

15. Diameter.—A right line passing through the center of a circle, or other curvilinear figure, terminated by the curve, and dividing the figure symmetrically into two equal parts.

16. Ellipse.—In conic sections, a figure formed by the intersection of a plane and cone when the plane passes obliquely through the opposite sides of the cone.

17. Equilateral Triangle.—A triangle having all three sides equal.

18. Hexagon.—A plane figure of six sides and six angles. If the sides and angles are equal, it is a regular hexagon. The cells of honey-comb are hexagons, and it is remarkable that bees instinctively form their cells of this figure, which fills any given space without any interstice or loss of room.

19. Hypothenuse.—The subtense or longest side of a right-angled triangle, or the line that subtends the right angle.

20. Rectangular Triangle.—If one of the angles of a triangle is a right angle, the triangle is rectangular.

21. Right Angle.—A right angle is one formed by a right line falling on another perpendicularly, or an angle of 90 degrees, making the quarter of a circle.

22. Isosceles Triangle.—If two of the sides only are equal in a triangle it is an isosceles or equicrural triangle.

23. Oblique Line.—An oblique line is one that, falling on another, makes oblique angles with it.

24. Obtuse Angle.—An angle greater than a right angle, or containing more than 90 degrees.

25. Scalene Triangle.—One in which all the three sides are unequal.

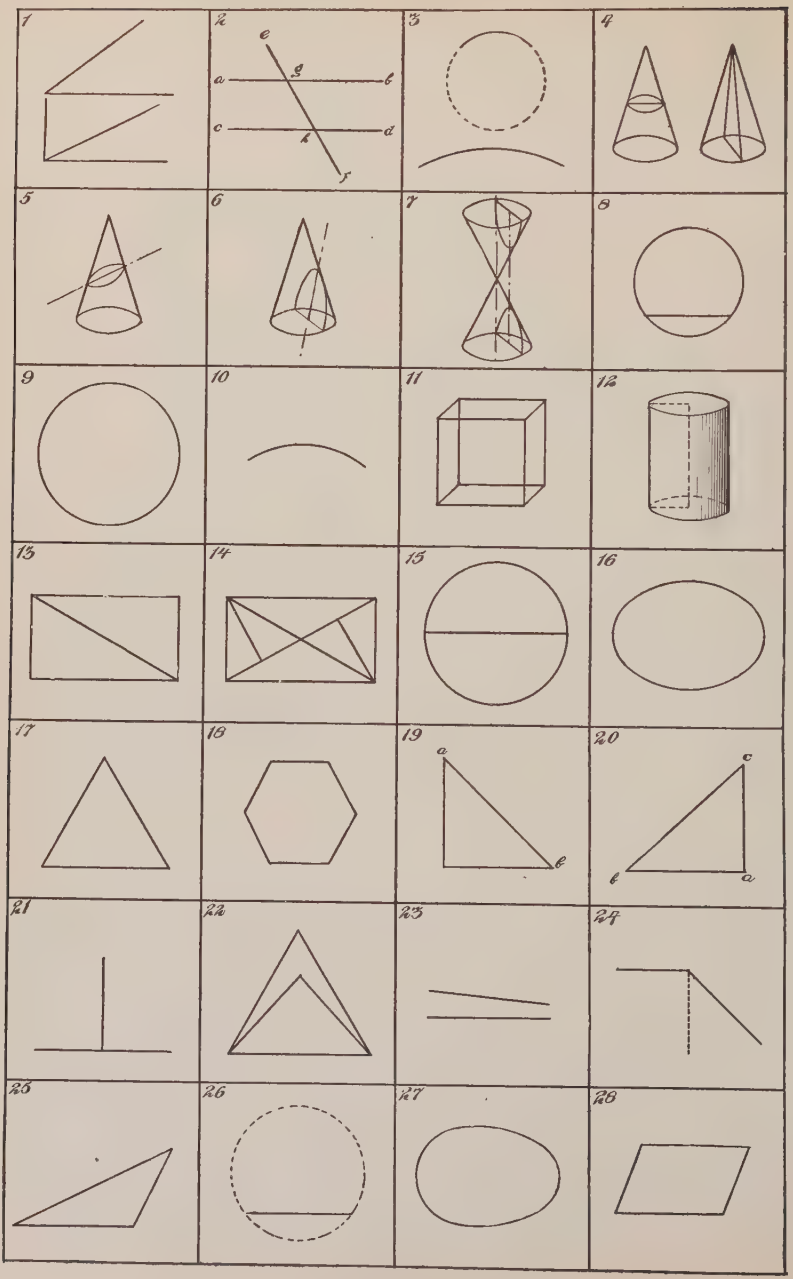
26. Secant.—The secant of a circle is a line drawn from the circumference on one side to a point without the circumference on the other.

27. Oval.—A body or figure in the shape of an egg, or of an ellipse.

28. Parallelogram.—1. In geometry, a right-lined quadrilateral figure, whose opposite sides are parallel, and consequently equal. 2. In common use, this word is applied to quadrilateral figures of more length than breadth.

29. Sector.—A part of a circle comprehended between two radii and the included arc; or a mixed triangle, formed by two radii and the arc of a circle.

30. Parallelopiped.—A regular solid comprehended under six parallelograms, the opposite ones of which are similar, parallel, and equal to each other; or it is a prism whose base is a parallelogram. It is always triple to a pyramid of the same base and height. Or a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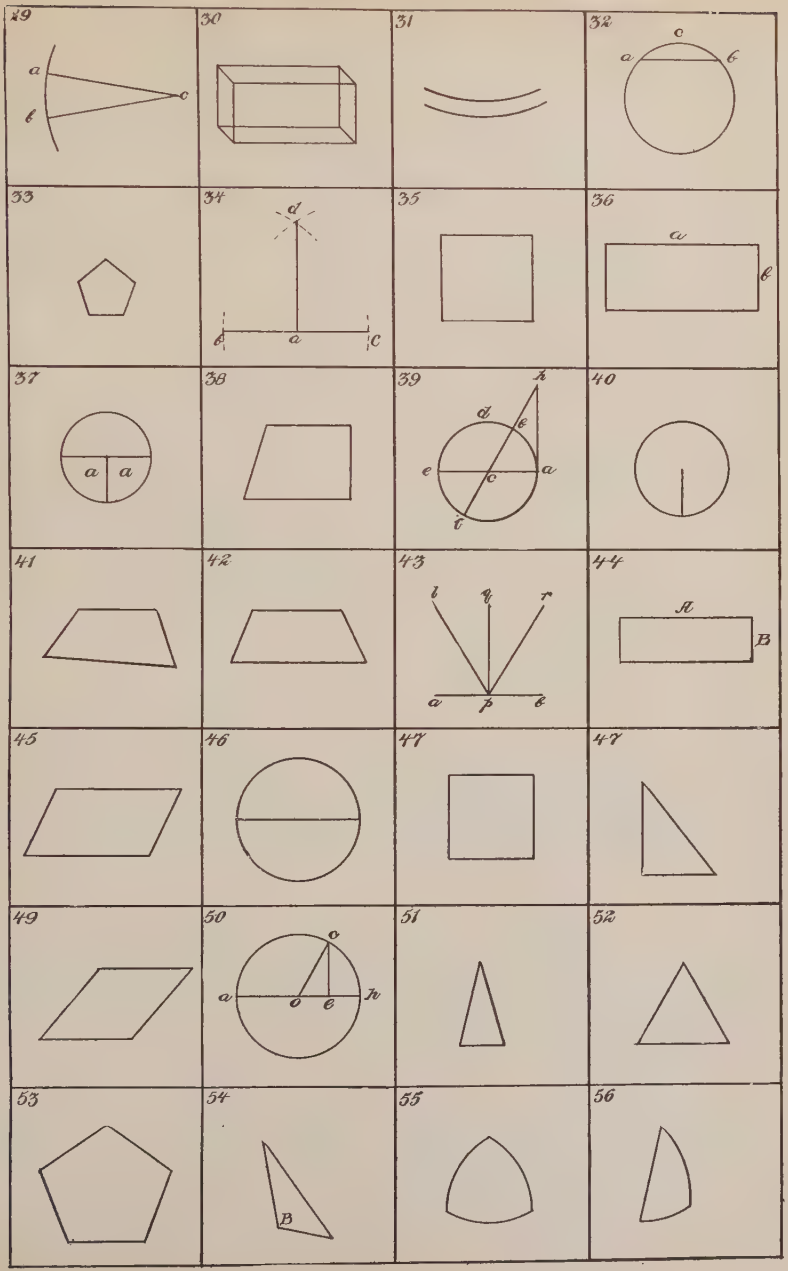
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parallelopiped is a solid figure bounded by six faces, parallel to each other, two and two.

31. Parallel Lines.—One line is parallel to another, when the lines are at an equal distance apart throughout the whole length.

32. Segment of a Circle.—That part of the circle contained between a chord and an arc of that circle, or so much of the circle as is cut off by the chord. The segment of a sphere is a part cut off by a plane.

33. Pentagon.—A plane figure having five angles, and consequently five sides.

34. Perpendicular.—In geometry, a line falling at right angles on another line, or making equal angles with it on each side. Thus if the straight line *AD*, falling on the straight line *BC*, make the angles *BAD*, *DAC* equal to one another, *AD* is called a perpendicular to *BC*.

35. Quadrangle.—A plane figure having four angles, and consequently four sides.

36. Rectangle.—A four-sided figure having only right angles. A right-angled parallelogram.

37. Quadrant.—The quarter of a circle or of the circumference of a circle.

38. Quadrilateral.—Having four sides, and consequently four angles.

39. Tangent.—In the figure, let *AH* be a straight line drawn touching the circle *ADE* at *A*, one extremity of the arc *AB*, and meeting the diameter *IB* produced, which passes through the other extremity *B* to the point *H*; then *AH* is the tangent of the arc *AB*, or of the angle *ACB*, of which *AB* is the measure.

40. Radius.—A right line drawn or extending from the center of a circle to the periphery; the semidiameter of the circle. In trigonometry, the radius is equal to the sine of 90 degrees.

41. Trapezium.—A plane figure contained under four right lines, of which no two are parallel.

42. Trapezoid.—A plane, four-sided figure, having two of the opposite sides parallel to each other.

43. Reflection.—In the figure, let *AB* represent a smooth polished surface, or mirror, and suppose a ray of light proceeding in the direction *LP* to impinge on the surface at *P*, and to be reflected from it in the direction *PR*. From *P* draw *PQ* perpendicular to *AB*, then the angle *LPQ* is called the angle of incidence, and *QPR* the angle of reflection.

44. Superficies.—A superficies consists of length and breadth; as, the superficies of a plate or of a sphere. Superficies is rectilinear, curvilinear, plane, convex, or concave.

45. Rhomboid.—A figure having some resemblance to a rhomb; or a quadrilateral figure whose opposite sides and angles are equal, but which is neither equilateral nor equiangular.

46. Semicircle.—The half of a circle; the part of a circle comprehended between its diameter and half of its circumference.

47. Square.—A rectilinear figure having four equal sides and four right angles.

48. Rectilinear Triangle.—One in which the three lines or sides are all right lines, as distinguished from curvilinear triangle.

49. Rhomb, Rhombus.—An oblique-angled, equilateral parallelogram, or a quadrilateral figure whose sides are equal and the opposite sides parallel, but the angles unequal, two of the angles being obtuse and two acute.

50. Sine.—In the circle *ACH*, let *AOH* be a diameter, and let *CE* be perpendicular thereto; then shall *CE* be the sine of the arc *CH*, or of the angle *COH*, and of its supplement *COA*. The sine of a quadrant, or of a right angle, is equal to the radius. The sine of any arc is half the chord of twice that arc.

51. Acute-angled Triangle.—One having all three of its angles acute.

52. An Equilateral Triangle.—One having all the three sides equal.

53. Polygon.—A plane figure of many angles, and consequently of many sides; particularly, one whose perimeter consists of more than four sides.

54. Obtusangular Triangle.—If one of the angles of a triangle is obtuse, the triangle is called obtusangular or amblygonous.

55. Curvilinear and Spherical Triangles.—If the three sides of a triangle are all curves, the triangle is said to be curvilinear. If the sides are all arcs of great circles of the sphere, the triangle is said to be spherical.

56. Mixtilinear Triangle.—If some of the sides of a triangle are right and others curve, the triangle is said to be mixtilinear.

## GEOMETRICAL CONSTRUCTIONS.*

1.

To divide a given line *A B* into two equal parts; and to erect a perpendicular through the middle.

With the end *A* and *B* as centers, draw the dotted circle arcs with a radius greater than half the line. Through the crossings of the arcs draw the perpendicular *C D*, which divides the line into two equal parts.

2.

From a given point *C* on the line *A B*, erect a perpendicular *C D*.

With *C* as a center, draw the dotted circle arcs at *A* and *B* equal distances from *C*. With *A* and *B* as centers, draw the dotted circle arcs at *D*. From the crossing *D* draw the required perpendicular *D C*.

3.

From a given point *C* at a distance from the line *A B*, draw a perpendicular to the line.

With *C* as a center, draw the dotted circle arc so that it cuts the line at *A* and *B*. With *A* and *B* as centers, draw the dotted cross arcs at *D* with equal radii. Draw the required perpendicular through *C* and crossing *D*.

4.

At the end of *A* to a given line *A B*, erect a perpendicular *A C*.

With the point *D* as a center at a distance from the line, and with *A D* as radius, draw the dotted circle arc so that it cuts the line at *E* through *E* and *D*, draw the diameter *E C*; then join *C* and *A*, which will be the required perpendicular.

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5.

Through a given point *C* at a distance from the line *A B*, draw a line *C D* parallel to *A B*.

With *C* as a center, draw the dotted arc *E D*, with *E* as a center, draw through *C* the dotted arc F. C. With the radius *F C* and *E* as a center, draw the cross arc at *D*. Join *C* with the cross at *D*, which will be the required parallel line.

6.

On a given line *A B* and at the point *B*, construct an angle equal to the angle *C D E*.

With *D* as a center, draw the dotted arc *C E;* and with the same radius and *B* as a ce ter, draw the arc *G F;* then make *G F* equal to *C E;* then join *B F*, which will form the required angle, *F B G=C D E*.

7.

Divide the angle *A C B* into two equal parts.

With *C* as a center, draw the dotted arc *D E;* with *D* and *E* as centers, draw the cross arcs at *F* with equal radii. Join *C F*, which divides the angle into the required parts.

Angles $A\ C\ F = F\ C\ B = \frac{1}{2}(A\ C\ B)$.

8.

Divide an angle into two equal parts, when the lines do not extend to a meeting point.

Draw the lines *C D* and *C E* parallel, and at equal distances from the lines *A B* and *F G*. With *C* as a center, draw the dotted arc *B G;* and with *B* and *G* as centers, draw the cross arcs *H*. Join *C H*, which divides the angle into the required equal parts.

9.

To construct a parallelogram, with the given sides *A* and *B* and angle *C*.

Draw the base line *D E*, and make the angle *F D E=C;* lines *D E=B* and *D F=A;* complete the parallelogram by cross arcs at *G*, and the problem is thus solved.

10.

To divide the line *A B* in the same proportion of parts as *A C*.

Join *C* and *B*, and through the given divisions 1, 2, and 3 draw lines parallel with *C B*, which solves the problem.

11.

To find the center of a circle which will pass through three given points *A*, *B*, and *C*.

With *B* as a center, draw the arc *D E F G;* and with the same radius and *A* as a center, draw the cross arcs *D* and *F;* also with *C* as a center, draw the cross arcs *E* and *G*. Join *D* and *F*, and also *E* and *G*, and the crossing *o* is the required center of the circle.

12.

To construct a square upon a given line *A B*.

With *A B* as radius and *A* and *B* as centers, draw the circle arcs*A E D* and *B E C*. Divide the arc *B E* in two equal parts at *F*, and with *E F* as radius, and *E* as center, draw the circle *C F D*. Join *A* and *C B* and *D*, *C* and *D*, which completes the required square.

13.

Through a given point *A* in a circumference, draw a tangent to the circle.

Through a given point *A* and center *C*, draw the line *B C*. With *A* as a center, draw the circle arcs *B* and *C;* with *B* and *C* as centers, draw the cross arcs *D* and *E;* then join *D* and *E*, which is the required tangent.

14.

From a given point *A* outside of a circumference, draw a tangent to the circle.

Join *A* and *C*, and upon *A C* as a diameter draw the half circle *A B C*, which cuts the given circle at *B*. Join *A* and *B*, which is the required tangent.

15.

To draw a circle with a given radius *R*, that will tangent the circle *A B C* at *C*.

Through the given point *C*, draw the diameter *A C* extended beyond *D;* from *C* set off the given radius *R* to *D;* then *D* is the center of the required circle, which tangents the given circle at *C*.

16.

To draw a circle with a given radius *R*, that will tangent two given circles.

Join the centers *A* and *B* of the given circles Add the given radius *R* to each of the radii of the given circle, and draw the cross arcs *C*, which is the center of the circle required to tangent the other two.

17.

To draw a tangent to two circles of different diameters.

Join the centers *C* and *c* of the given circles, and extend the line to *D;* draw the radii *A C* and *a c* parallel with one another. Join *A a*, and extend the line to *D*. On *C D* as a diameter, draw the half circle *C e D;* on *c D* as a diameter, draw the half circle *c f D;* then the crossings *e* and *f* are the tangenting points of the circles.

18.

To draw a tangent between two circles.

Join the centers *C* and *c* of the given circles; draw the dotted circle arcs, and join the crossing *m*, *n*, which line cuts the center line at *a*. With *a C* as a diameter, draw the half circle *a f C;* and with *a c* as a diameter, draw the half circle *c e a;* then the crossings *e* and *f* are the tangenting points of the circles.

19.

With a given radius *r*, draw a circle that will tangent the given line *A B* and the given circle *C D*.

Add the given radius *r* to the radius *R* of the circle, and draw the arc *c d*. Draw the line *c e* parallel with and at a distance *r* from the line *A B*. Then the crossing *c* is the center of the required circle that will tangent the given line and circle.

20.

To find the center and radius of a circle that will tangent the given circle *A B* at *C*, and the line *D E*.

Through the given point *C*, draw the tangent *G F;* bisect the angle *F G E;* then *o* is the center of the required circle that will tangent *A B* at *C*, and the line *D E*.

21.

To find the center and radius of a circle that

will tangent the given line *A B* at *C*, and the circle *D E*.

Through the point *C*, draw the line *E F* at right angles to *A B;* set off from *C* the radius *r* of the given circle. Join *G* and *F*. With *G* and *F* as centers draw the arc crosses *m* and *n*. Join *m n*, and where it crosses the line *E F* is the center for the required circles.

22.

To find the center and radius of a circle that will tangent the given line *A B* at *C*, and the circle *D E*.

From *C*, erect the perpendicular *C G;* set off the given radius *r* from *C* to *H*. With *H* as a center and *r* as radius, draw the cross arcs on the circle. Through the cross arcs draw the line *I G;* then *G* is the center of the circle arc *F I C*, which tangents the line at *C* and the circle at *F*.

23.

Between two given lines, draw two circles that will tangent themselves and the lines.

Draw the center line *A B* between the given lines; assume *D* to be the tangenting point of the circles; draw *D C* at right angles to *A B*. With *C* as center and *C D* as radius, draw the circle *E D F*. From *E*, draw *E m* at right angles to *E F;* and from *F* draw *F m* at right angles to *F E;* then *m* and *n* are the centers for the required circles.

24.

Draw a circle that will tangent two given lines *A B* and *C D* inclined to one another and the one tangenting point *E* being given.

Draw the center line *G F*. From *E*, draw *E F* at right angles to *A B;* then *F* is the center of the circle required.

25.

Draw a circle that will tangent two lines and go through a given point *C* on the line *F C*, which bisects the angle of the lines.

Through *C* draw *A B* at right angles to *C F;* bisect the angles *D A B* and *E B A*, and the crossing on *C F* is the center of the required circle.

26.

To draw a *cyma*, or two circle arcs that will tangent themselves, and two parallel lines at given points *A* and *B*.

Join *A* and *B;* divide *A B* into four equal parts and erect perpendiculars. Draw *A m* at right angles from *A*, and *B n* at right angles from *B;* then *m* and *n* are the centers of the circle arcs of the required *cyma*.

27.

To draw a *talon*, or two circle arcs, that will tangent themselves, and meet two parallel lines at right angles in the given points *A* and *B*.

Join *A* and *B;* divide *A B* into four equal parts and erect perpendiculars; then *m* and *n* are the centers of the circle arcs of the required *talon*.

28.

To plot out a circle arc without recourse to its center, but its chord *A B* and height *h* being given.

With the chord as radius, and *A* and *B* as centers, draw the dotted circle arcs *A C* and *B D*. Through the point *O* draw the lines *A O o* and *B O o*. Make the arcs *C o* = *A o* and *D o* = *B o*. Divide these arcs into any desired number of equal parts, and number them as shown on the illustration. Join *A* and *B* with the divisions, and the crossings of equal numbers are points in the circle arc.

29.

To find the center and radius of a circle that will tangent the three sides of a triangle.

Bisect two of the angles in the triangle, and the crossing *C* is the center of the required circle.

30.

To inscribe an equilateral triangle in a circle.

With the radius of the circle and center *C* draw the arc *D F E;* with the same radius, and *D* and *E* as centers, set off the points *A* and *B*. Join *A* and *B*, *B* and *C*, *C* and *A*, which will be the required triangle.

31.

To inscribe a square in a given circle.

Draw the diameter *A B*, and through the center erect the perpendicular C D, and complete the square as shown in the illustration.

32.

To describe a square about a given circle.

Draw the diameters *A B* and *C D* at right angles to one another; with the radius of the circle, and *A*, *B*, *C*, and *D* as centers, draw the four dotted half circles which cross one another in the corners of the square, and thus complete the problem.

33.

To inscribe a *pentagon* in a given circle.

Draw the diameter *A B*, and from the center *C* erect the perpendicular *C D*. Bisect the radius *A C* at *E;* with *E* as center, and *D E* as radius, draw the arc *D E*, and the straight line *D F* is the length of the side of the pentagon.

34.

To construct a *pentagon* on a given line *A B*.

From B erect *B C* perpendicular to and half the length of *A B;* join *A* and *C* prolonged to *D;* with *C* as a center and *C B* as radius, draw the arc *B D;* then the chord *B B* is the radius of the circle circumscribing the pentagon. With *A* and *B* as centers, and *B D* as radius, draw the cross *O* in the center.

35.

To construct a pentagon on a given line *A B* without resort to its center.

From *B* erect *B o* perpendicular and equal to *A B;* with *C* as center and *C o* as radius, draw the arc *D o;* then *A D* is the diagonal of the pentagon. With *A D* as radius and *A* as center, draw the arc *D E;* and with *E* as center and *A B* as radius, finish the cross *E*, and thus complete the pentagon.

36.

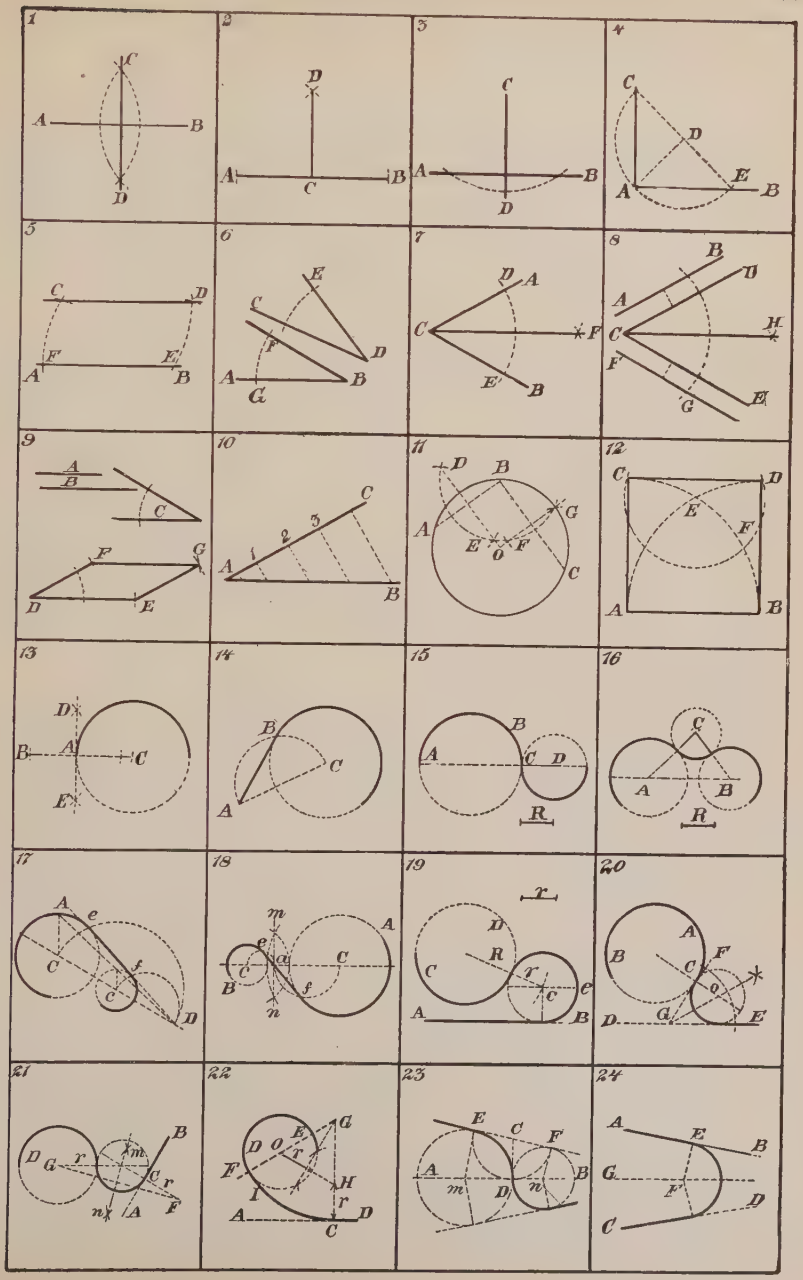
To construct a *hexagon* in a given circle.

The radius of the circle is equal to the side of the hexagon.

37.

*To construct a Heptagon.*

The appotem *a* in a hexagon is the length of the side of the heptagon.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Set off *A B* equal to the radius of the circle; draw *a* from the center *C* at right angles to *A B;* then *a* is the required side of the heptagon.

38.

To construct an *octagon* on the given line *A B.*

Prolong *A B* to *C.* With *B* as center and *A B* as radius, draw the circle *A F D E C;* from *B*, draw *B I* at right angles to *A B;* divide the angles *A B D* and *D B C* each into two equal parts; then *B E* is one side of the octagon. With *A* and *E* as centers, draw the arcs *H K E* and *A K I*, which determine the points *H* and *I*, and thus complete the octagon as shown in the illustration.

39.

To cut off the corners of a square, so as to make of it a regular *octagon.*

With the corners as centers, draw circle arcs through the center of the square to the side, which determines the cut-off.

40.

The area of a regular polygon is equal to the area of a triangle whose base is equal to the sum of all the sides, and the height *a* equal to the appotem of the polygon.

The reason of this is that the area of two or more triangles *A B C* and *A D C* having a common or equal base *b* and equal height *h* are alike.

41.

To construct any regular *polygon* on a given line *A B* without resort to its center.

Extend *A B* to *C* and, with *B* as center, draw the half circle *A D B.* Divide the half circle into as many parts as the number of sides in the polygon, and complete the construction as shown on the illustration.

42.

To construct an isometric ellipse by compasess and six circle arcs.

Divide *O A* and *O B* each into three equal parts; draw the quadrant *A C.* From *C*, draw the line *C c* through the point 1. Through the points 2 draw *d e* at an angle of 45° with the major axis. Then 2 is the center for the ends of the ellipse; *e* is the center for the arc *d c;* and *C* is the center for the arc *c f.*

43.

*To construct a Hyperbola by plotting,*

Having given the transverse axis *B C*, vertexes *A a*, and foci *f f'*. Set off any desired number of parts on the axis below the focus, and number them 1, 2, 3, 4, 5, etc. Take the distance *a* 1 as radius, and, with *f'* as center, strike the cross 1 with *f'* 1 = *a* 1. With the distance *A* 1, and the focus *f* as center, strike the cross 1 with the radius *F* 1 = *A* 1, and the cross 1 is a point in the hyperbola.

44.

*To draw an Hyperbola by a pencil and a string,*

Having given the transverse axis *B C*, foci *f'* and *f*, and the vertexes *A* and *a*. Take a rule and fix it to a string at *e;* fix the other end of the string at the focus *f*. The length of the string should be such that when the rule *R* is in the position *f' C*, the loop of the string should reach to *A;* then move the rule on the focus *f'*, and a pencil at *P*, stretching string, will trace the hyperbola.

45.

*To construct a Parabola by plotting,*

Having given the axis, vertex, and focus of the parabola. Divide the transverse axis into any desired number of parts 1, 2, 3, etc., and draw ordinates through the divisions; take the distance *A* 1, and set it off on the 1st ordinate from the focus *f* to *a*, so that *A* 1 = *f a*. Repeat the same operation with the other ordinates—that is, set off the distance *A* 5 from *f* to *e*, so that *A* 5 = *f e;* and so the parabola is constructed.

46.

*To draw a Parabola with a pencil and a string,*

Having given the two axes, vertex, and focus of the parabola. Take a square *c d e*, and fix to it a string at *e;* fix the other end of the string at the focus *f*. The length of the string should be such that when the square is in the position of the axis *A f*, the string should reach to the vertex *A*. Move the square along *B B*, and the pencil *P* will describe the parabola.

47.

*Shield's anti-friction curve.*

*R* represents the radius of the shaft, and *C* 1, 2, 3, etc., is the center line of the shaft. From *o*, set off the small distance *o a;* and set off *a* 1 = *R*. Set off the two same small distance from *a* to *b*, and make *b* 2 = *R*. Continue in the same way with the other points, and the anti-friction curve is thus constructed.

48.

*Isometric Perspective.*

This kind of perspective admits of scale measurements the same as any ordinary drawing, and gives a clear representation of the object. It is easily learned. All horizontal rectangular lines are drawn at an angle of 30°.

All circles are ellipses of proportion, as shown in No. 42, on the following page.

49.

*To construct an ellipse.*

With *a* as a center, draw two concentric circles with diameters equal to the long and short axes of the desired ellipse. Draw from *o* any number of radii, *A*, *B*, etc. Draw a line *B b'* parallel to *n* and *b b'* parallel to *m*, then *b* is a point in the desired ellipse.

50.

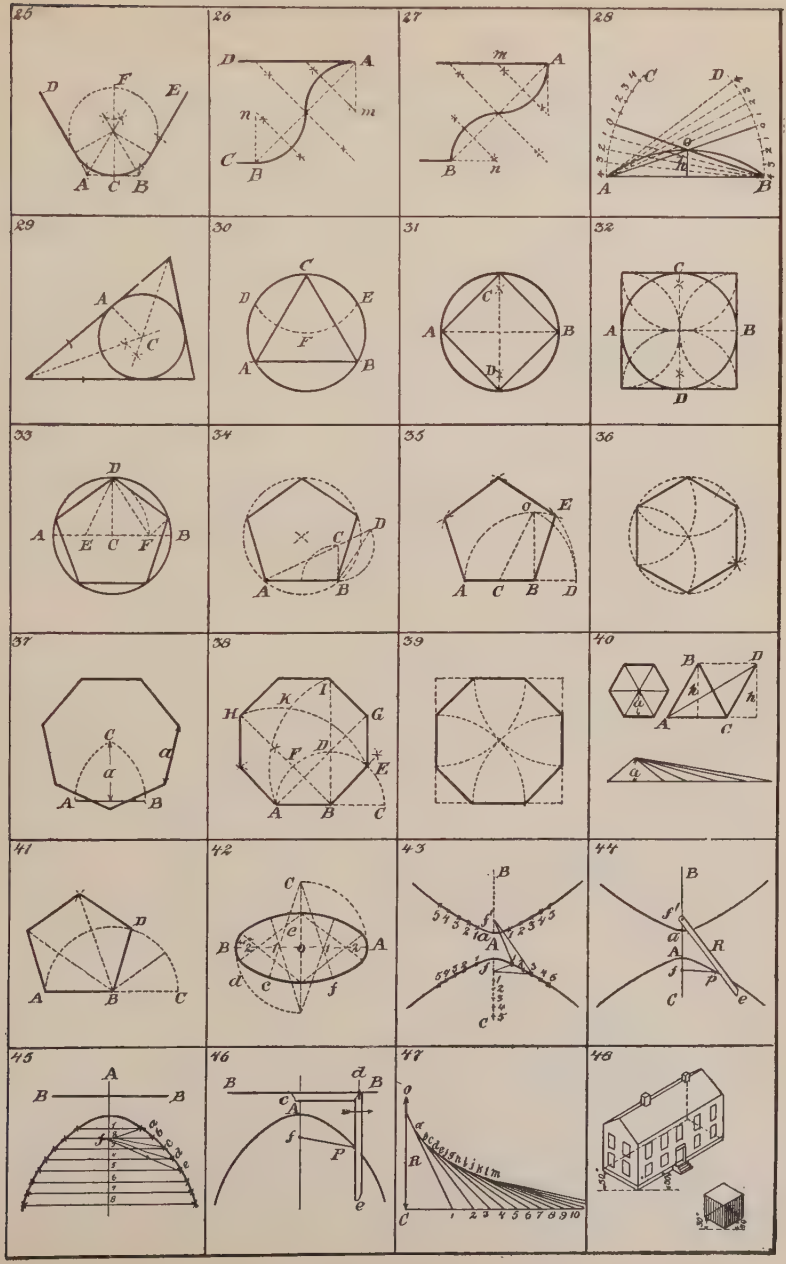
*To draw an ellipse with a string.*

Having given the two axes, set off from *c* half the great axis at *a* and *b*, which are the two focuses of the ellipse. Take an endless string as long as the three sides in the triangle *a b c*, fix two pins or nails in the focuses, one in *a* and one in *b*, lay the string around *a* and *b*, stretch it with a pencil *d*, which then will describe the desired ellipse.

51.

*To draw an ellipse by circle arcs.*

Divide the long axis into three equal parts, draw the two circles, and where they intersect one another are the centers for the tangent arcs of the ellipse as shown by the figure.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D F E A C B
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D A n m C B
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m A B n
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C e B A d c f
43
B A C
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B f' a A R f p C e
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A B B
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B d B c A f P e
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0 R C 1 2 3 4 5 6 7 8 9 10
48

52.

*To draw an ellipse by circle arcs.*

Given the two axes, set off the short axis from $A$ to $b$, divide $b$ into three equal parts, set off two of these parts from $o$ towards $c$ and $c$ which are the centers for the ends of the ellipse. Make equilateral triangles on $c\,c$, when $e\,e$ will be the centers for the sides of the ellipse. If the long axis is more than twice the short one, this construction will not make a good ellipse.

53.

*To construct an ellipse.*

Given the two axes, set off half the long axis from $c$ to $f\,f$, which will be the two focuses in the ellipse. Divide the long axis into any number of parts, say $a$ to be a division point. Take $A\,a$ as radius and $f$ as center and describe a circle arc about $b$, take $a\,B$ as radius and $f$ as center describe another circle arc about $b$, then the intersection $b$ is a point in the ellipse, and so the whole ellipse can be constructed.

54.

*To draw an ellipse that will tangent two parallel lines in A and B.*

Draw a semicircle on $A\,B$, draw ordinates in the circle at right angle to $A\,B$, the corresponding and equal ordinates for the ellipse to be drawn parallel to the lines, and thus the elliptic curve is obtained as shown by the figure.

55.

*To construct a cycloid.*

The circumference $C=3.14\,D$. Divide the rolling circle and base line $C$ into a number of equal parts, draw through the division point the ordinates and abscissas, make $a\,a'=1\,d$, $b\,b'=2'e$, $c\,c=3\,f$, then $a\,b'$ and $c'$ are points in the cycloid. In the *Epicycloid* and *Hypocycloid* the abscissas are circles and the ordinates are radii to one common center.

56.

*Evolute of a circle.*

Given the pitch $p$, the angle $v$, and radius $r$. Divide the angle $v$ into a number of equal parts, draw the radii and tangents for each part, divide the pitch $p$ into an equal number of equal parts, then the first tangent will be one part, second two parts, third three parts, etc., and so the *Evolute* is traced.

57.

*To construct a spiral with compasses and four centers.*

Given the pitch of the spiral, construct a square about the center, with the four sides together equal to the pitch. Prolong the sides in one direction as shown by the figure, the corners are the centers for each arc of the external angles.

58.

*To construct a Parabola.*

Given the vertex $A$, axis $x$, and a point $P$. Draw $A\,B$ at right angle to $x$, and $B\,P$ parallel to $x$, divide $A\,B$ and $B\,P$ into an equal number of equal parts. From the vertex $A$ draw lines to the divisions on $B\,P$, from the divisions on $A\,B$ draw the ordinates parallel to $x$, the corresponding intersections are points in the *parabola*.

59.

*To construct a Parabola.*

Given the axis of ordinate $B$, and vertex $A$. Take $A$ as a center and describe a semicircle from $B$ which gives the focus of the *parabola* at $f$. Draw any ordinate $y$ at right angle to the abscissa $A\,x$, take $a$ as radius and the focus $f$ as a center, then intersect the ordinate $y$, by a circle-arc in $P$ which will be a point in the *parabola*. In the same manner the whole Parabola is constructed.

60.

*To draw an arithmetic spiral.*

Given the pitch $p$ and angle $v$, divide them into an equal number of equal parts, say 6; make $0\,1=0\,1$, $0\,2=0\,2$, $0\,3=0\,3$, $0\,4=0\,4$, $0\,5=0\,5$, and $0\,6=$the pitch $p$; then join the points 1, 2, 3, 4, 5 and 6, which will form the spiral required.

## THE CIRCLE.

*Notation of Letters.*

$d$ = diameter of the circle.
$r$ = radius of the circle.
$p$ = periphery or circumference.
$a$ = area of a circle or part thereof.
$b$ = length of a circle arc.
$c$ = chord of a segment, length of.
$h$ = height of a segment.
$s$ = side of a rectangular polygon
$v$ = center angle.
$w$ = polygon angle.

All measures must be expressed by the same unit.

## FORMULAS FOR THE CIRCLE.

*Periphery or Circumference.*

$p=\pi\,d=3.14d.$

$p=2\pi\,r=6.28r.$

$p=2\sqrt{\pi\,a}=3.54\sqrt{a}.$

$$p=\frac{2a}{r}=\frac{4a}{d}.$$

*Diameter and Radius.*

$$d=\frac{p}{\pi}=\frac{p}{3.14}.$$

$$r=\frac{p}{2\pi}=\frac{p}{6.28}.$$

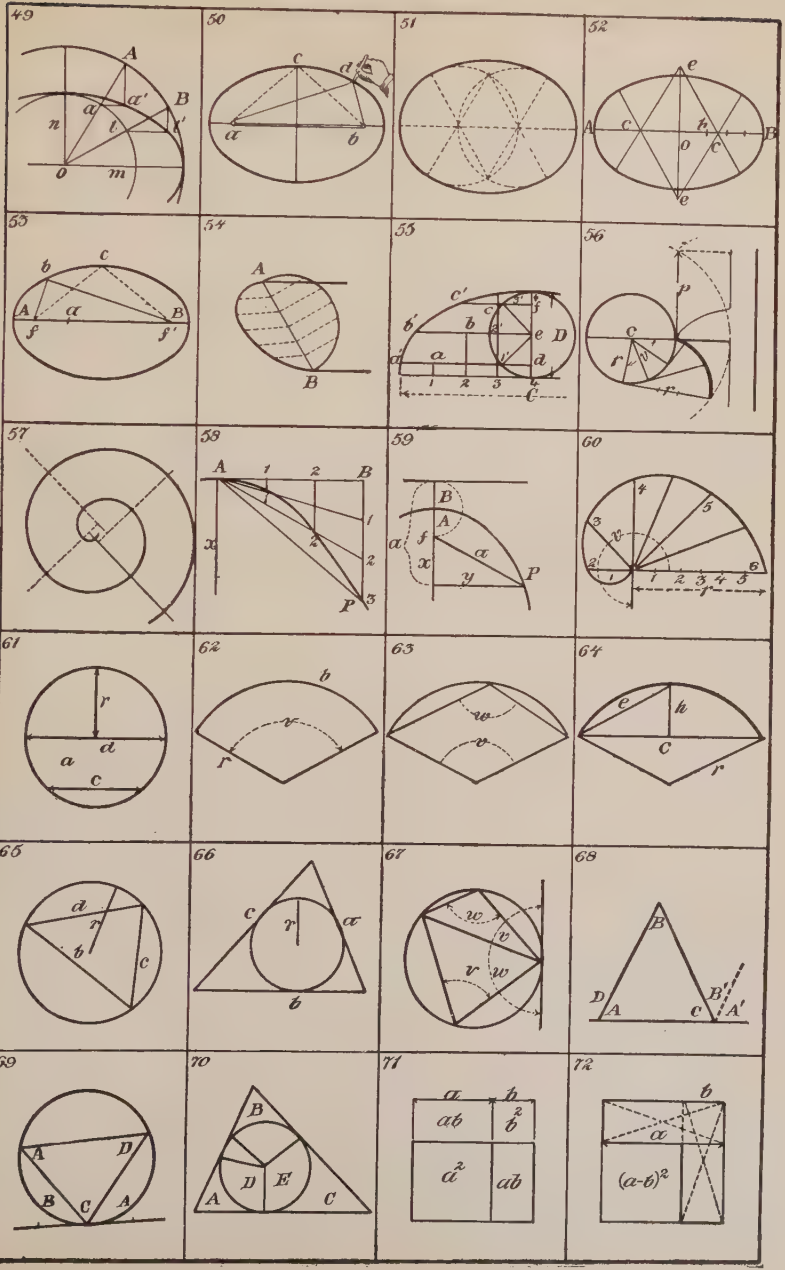
$$d=2\sqrt{\frac{a}{\pi}}=1.128\sqrt{a}$$

$$r=\sqrt{\frac{a}{\pi}}=0.564\sqrt{a}.$$

*Area of the Circle.*

$$a=\frac{\pi\,d^2}{4}=0.785d^2$$

$a=\pi\,r^2=3.14r^2.$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$(a-b)^2$

$$a=\frac{p^2}{4\pi}=\frac{p^2}{12.56}.$$

$$a=\frac{pr}{2}=\frac{pd}{4}.$$

---

$\pi=3.14159265358979323846264338327950288$
$4197169399$

$2\pi=6.283185$
$3\pi=9.424778$
$4\pi=12.566370$
$5\pi=15.707963$
$6\pi=18.849556$
$7\pi=21.991148$
$8\pi=25.132741$
$9\pi=28.274334$
$\frac{1}{4}\pi=0.785398$
$\frac{1}{3}\pi=1.047197$
$\frac{1}{2}\pi=1.570796$
$\frac{1}{9}\pi=0.392699$
$\frac{1}{6}\pi=0.523599$
$\frac{1}{12}\pi=0.261799$
$\frac{2}{3}\pi=2.094394$
$\frac{1}{360}\pi=0.008726$
$\frac{1}{\pi}=0.318310$
$\frac{2}{\pi}=0.636619$
$\frac{3}{\pi}=0.954929$
$\frac{4}{\pi}=1.273239$
$\frac{6}{\pi}=1.909859$
$\frac{8}{\pi}=2.546478$
$\frac{12}{\pi}=3.819718$
$\frac{360}{\pi}=114.5915$
$\pi^2=9.869650$
$\sqrt{\pi}=1.772453$
$\sqrt{\frac{1}{\pi}}=0.564189$
$\sqrt{\frac{\pi}{2}}=1.253314$
$\sqrt{\frac{2}{\pi}}=0.797884$
Log. $\pi=0.49714987$

61.

The periphery of a Circle is commonly expressed by the *Greek* letter $\pi=3.14$ when the diameter $d=1$ or the unit. For any other value of the diameter $d$, we will denote the periphery by the letter $p$, $r$=radius, and $a$=area of the circle. The periphery of a circle is equal to 3 14-100 times its diameter. $c$=chord.

62.

$$b=\frac{\pi rv}{180}=0.0175rv,$$

$$v=\frac{180b}{\pi r}=57.296\frac{b}{r}.$$

63.

$$w=180-\frac{v}{2},$$

$$v=2(180^\circ-w).$$

64.

$$r=\frac{c^2+4h^2}{8h}=\frac{e^2}{2h},$$

$$c=2\sqrt{2hr-h^2}.$$

65.

$$r=\frac{ac}{2\sqrt{a^2-\left(\frac{a^2+b^2-c^2}{2b}\right)^2}}.$$

66.

$$r=\frac{b\sqrt{a^2-\left(\frac{a^2+b^2-c^2}{2b}\right)^2}}{a+b+c}.$$

67.

$$v=v,\quad w=w,$$

$$w+v=180^\circ,\ w>v.$$

68.

$$D=B+C,\quad A'+B'+C=180^\circ,$$
$$B=D-C,\quad A+B+C=180^\circ,$$
$$A'=A,\quad B'=B.$$

69.

$$A+B+C=180^\circ,$$

$$A'=A,\quad B'=B.$$

70.

$$E+C=A+D=180^\circ,$$
$$D=B+c,$$
$$E=A+B.$$

71.

$$(a+b)^2=a^2+2ab+b^2.$$

72.

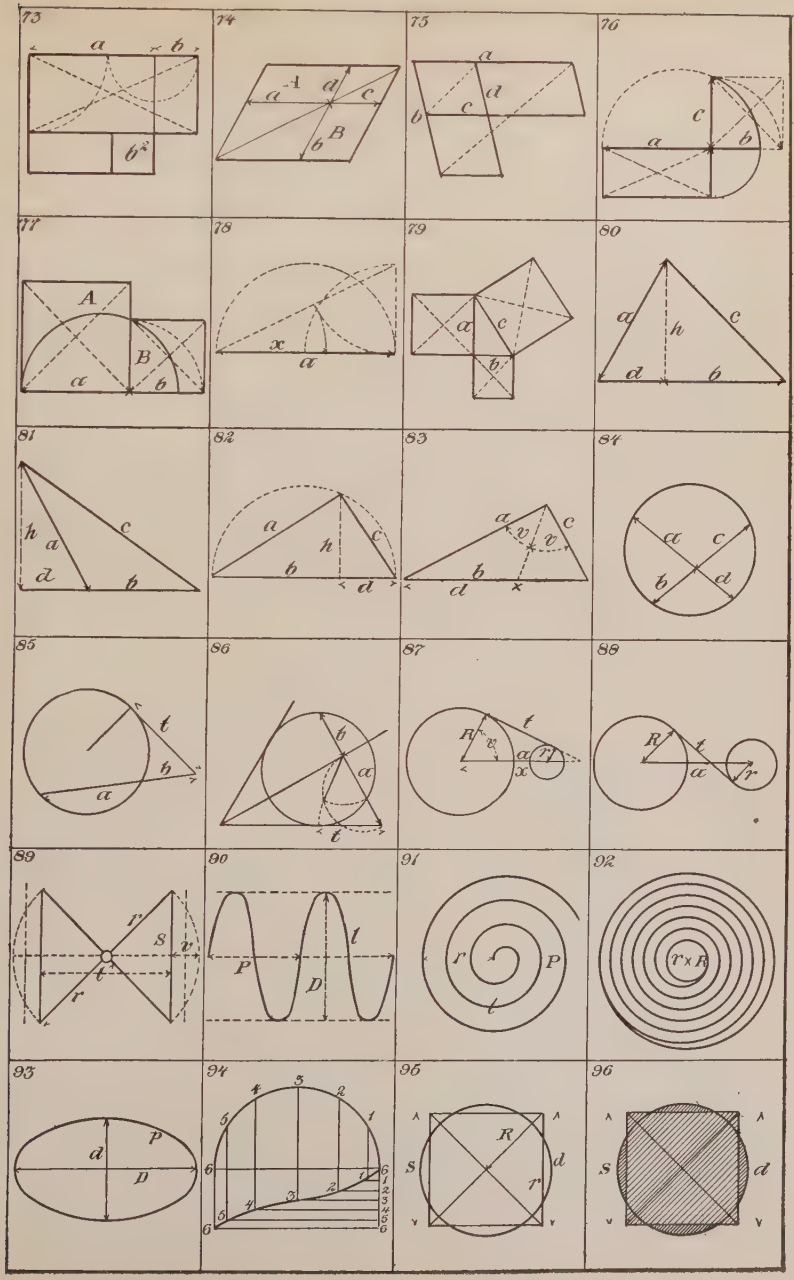
$$(a-b)^2=a^2-2ab+b^2.$$

73.

$$(a+b)\ (a-b)=a^2-b^2.$$

74.

$$a:b=c:d,$$
$$ad=bc,$$
$$A=B.$$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75.

$a : b = c : d,$

$ad = bc.$

76.

$a : c = c : b,$

$ab = c^2,$

$c = \sqrt{ab}.$

77.

$A : B = a : b.$

78.

$a \cdot x = x : a - x,$

$$x = \sqrt{a^2 + \left(\frac{a}{2}\right)^2} - \frac{a}{2}$$

79.

$c^2 = a^2 + b^2,$

$a^2 = c^2 - b^2,$

$b^2 = c^2 - a^2.$

80.

$c^2 = a^2 + b^2 - 2bd,$

$h = \sqrt{a^2 - d^2}.$

$$d = \frac{a^2 + b^2 - c^2}{2b}.$$

81.

$c^2 = a^2 + b^2 + 2bd,$

$h^2 = \sqrt{a^2 - d^2},$

$$d = \frac{c^2 - a^2 - b^2}{2b}.$$

82.

$a : b = h : c,$

$$h = \frac{ac}{b} = \frac{ad}{c},$$

$$d = \frac{c^2}{b} = \frac{ch}{a}.$$

83.

$a : c = d : (b - d),$

$$d = \frac{ab}{c + a},$$

$v = v.$

84.

$a : c = b : d,$

$ad = bc.$

85.

$a : t = t : b,$

$t^2 = ab.$

86.

$t^2 = (a + b)\ (a - b),$

$t = \sqrt{a^2 - b^2},$

87.

$$x = \frac{aR}{R - r}, \quad a = \sqrt{t^2 + (R - r)^2},$$

$$t = \sqrt{a^2 - (R - r)^2}, \quad \sin.v = \frac{t}{a}.$$

88.

$t = \sqrt{a^2 - (R + r)^2},$

$a = \sqrt{t^2 + (R + r)^2}.$

89.

$$V = r - \sqrt{r^2 - \frac{S^2}{4}} \qquad l = 2r - V,$$

$$S = 2\sqrt{r^2 - (r - V)^2}. \quad r = \tfrac{1}{2}(l + V).$$

90.

$$P = \sqrt{\frac{l^2}{n^2} - \pi^2 d^2},$$

$$l = n\sqrt{\pi^2 d^2 + P^2},$$

$$n = \frac{l}{\sqrt{\pi^2 d^2 + P}}.$$

91.

*To find the length of a Spiral.*

$$l - \pi r n = \frac{\pi r^2}{P}, \qquad n - \frac{l}{\pi r} = \frac{r}{P},$$

$$P = \frac{\pi r^2}{l} = \frac{r}{n}. \quad P = Pitch.$$

92.

*To find the length of a Spiral.*

$l = \pi\ n\ (R + r),$

$$l = \frac{\pi}{P}(R^2 - r^2).$$

93.

*Periphery of an Ellipse.*

$p = 2\sqrt{D2 + 1.4674d^2}.$

94.

To construct a screw *Helix.*

95.

*To square a Circumference.*

$R = 0.555355\ d = 1.1107\ r = 0.7071\ S.$

$S = 0.785398\ d = 1.57079\ r = 1.4142\ R$

$d = 1.27322\ S = 1.79740\ R = 2r.$

96.

*To square a Circleplane.*

$R = 0.626657\ d = 1.253314\ r = 0.7071\ S$

$S = 0.886226\ d = 1.77245\ r = 1.4142\ R$

$d = 1.12838\ S = 1.5367\ R = 2\ r.$

# CHAPTER II.

## MACHINE ELEMENTS

The Machine Elements or Powers are the Lever and the Inclined Plane. Every machine when analyzed is found to be made up of these elements, either singly or in combination; for example, pulleys, gear wheels, etc., are forms of levers, while screws, cams, etc., are forms of inclined planes.

There are four distinct types of levers, as shown in our illustration.

1st. The Common Lever, consisting of a straight inflexible bar movable on a fulcrum. The section of the bar extending from the fulcrum to the point where the power is applied is called the Power Arm, and the section extending from the fulcrum to the point where the weight is applied is called the Weight Arm.

2d. The Angular or Bell Crank Lever. This is distinguished from the Common Lever in having its power arms disposed at an angle to the weight arms.

3d. The Wheel and Axle, or Revolving Lever. A wheel and axle or two concentric wheels take the place of the power and weight arms. The weight is attached to a rope coiled on one of the wheels, and the power is attached to a rope coiled on the other wheel. The relation of this lever to the common lever is indicated by the dotted lines, and it will be evident that this relation remains constant even when the wheels are revolving.

4th. The Pulley. Another type of revolving lever, but differing from the wheel and axle type in that a single wheel is used and the fulcrum is not necessarily always at the center of the wheel.

Each of these types of the simple lever is capable of three different arrangements usually termed "Orders." In the First Order the fulcrum lies between the weight and the power. In the Second Order the weight lies between the fulcrum and the power. In the Third Order the power lies between the fulcrum and the weight. The second order gives the longest power arm relative to the weight arm, and consequently is the most powerful lever of the three. The formulæ for determining the amount of power required to balance a given weight, are given at the bottom of the illustration. In measuring the arms of the angular levers the measurements should not be taken along the length of the arms, but in the horizontal plane as shown, because this measurement represents the true theoretical length of the lever arm. As the lever is moved about the fulcrum, the ratio of the power arm to the weight arm changes as indicated by dotted lines in the first order of angular levers, because the arm that is approaching the horizontal plane is increasing in length, while the other which is moving toward the vertical plane is decreasing in length. The same is true in a modified form of the second and third orders of angular levers.

In the case of the pulleys the power and weight arms bear a definite relation to each other. No matter what their size may be, the power arm will always be of the same length as the weight arm in pulleys of the first order, consequently the power must be equal to the weight in order to keep the lever in equilibrium. In pulleys of the second order the power arm will be twice the length of the weight arm, consequently the power must be equal to half of the weight in order to keep the lever in equilibrium; and in pulleys of the third order the power arm will be half the length of the weight arm, consequently the power must equal twice the weight in order to maintain the equilibrium of the lever.

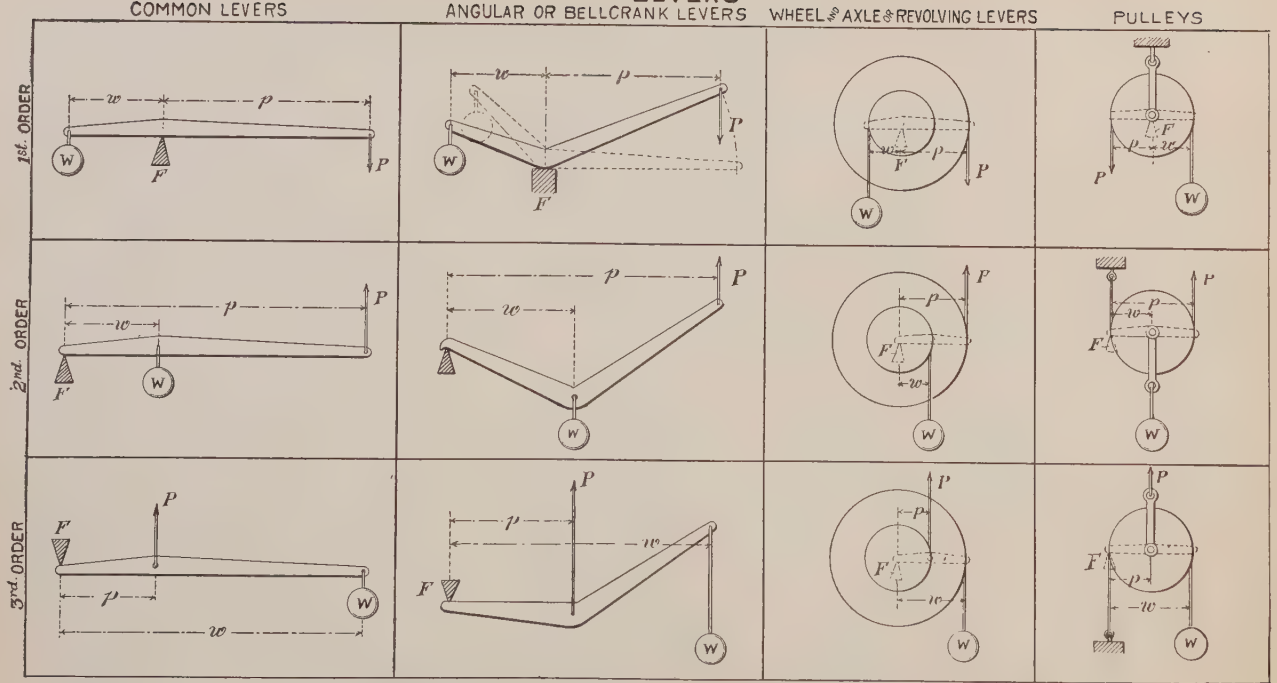
The compound levers consist of two or more simple levers of the same or different orders coupled together, either for the purposes of convenience or to increase the power.

Of the two compound common levers illustrated, Figure 1 shows two common levers of the first order coupled together, and Figure 2 represents a common lever of the first order coupled to a common lever of the second order.

The compound revolving lever illustrated is a combination of a wheel and axle of the second order, operating a pulley of the second order. This compound lever is also called a "Chinese windlass," owing to its early use by the Chinese for lifting heavy weights, such as draw-bridges. etc.

The compound pulleys or tackle shown are various combinations of pulleys of the same or different orders. As in the case of the simple pulleys, the weight and power arms bear a constant relation to each other, and it is therefore possible to give the numerical value of the power in terms of the weight, or *vice versa*, afforded by the different types of tackle, regardless of the size of the individual pulleys they comprise. The following simple formula is applicable to all tackle in which a continuous length of rope is used, as in Figures 1, 2, and 3: *Power equals weight divided by the number of rope parts supporting the weight.* In Figure 3, for instance, there are five such parts, not counting of course the part on which the power is applied. Figures 4 to 9 are all rather complex, owing to the fact that the power is transmitted to the weight through one or more movable pulley blocks connected by separate ropes. Figures 4 and 5 show tackle arrangements called Spanish burtons. A general formula, applicable to any number of pulleys arranged as in Fig. 6, is $P = \frac{W}{2^n - 1}$,

# LEVERS




P=POWER W=WEIGHT F=FULCRUM $p$=POWER ARM AND $w$=WEIGHT ARM $P=\frac{W\times w}{p}$ AND $W=\frac{P\times p}{w}$

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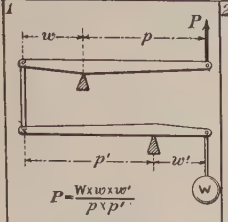
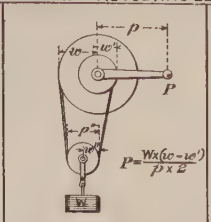
# COMPOUND LEVERAGE

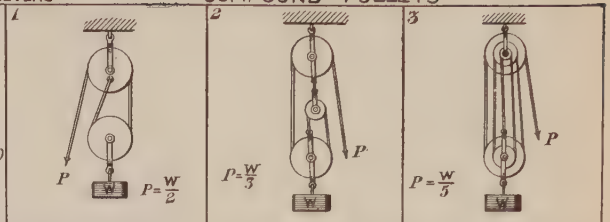
## COMPOUND COMMON LEVERS

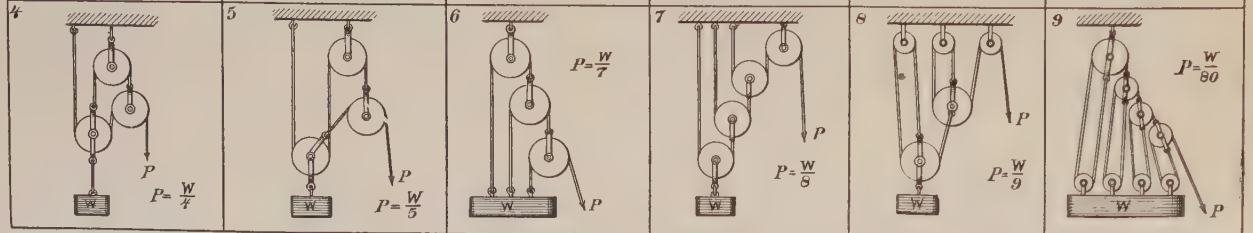



## COMPOUND REVOLVING LEVERS



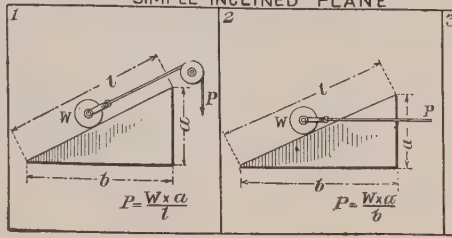

## COMPOUND PULLEYS



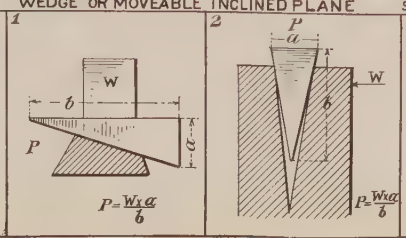




# INCLINED PLANE

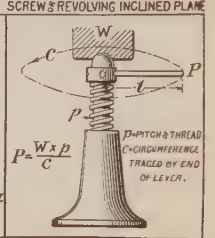
## SIMPLE INCLINED PLANE




## WEDGE OR MOVEABLE INCLINED PLANE




## SCREW & REVOLVING INCLINED PLANE

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in which $P$ represents the power, $W$ the weight, and $n$ the number of ropes used. The general formula for the arrangement shown in Figure 7 is $P=\frac{W}{2^n}$. The general formula for the arrangement shown in Figure 8 is $P=\frac{W}{3^n}$. The general formula for the arrangement shown in Figure 9 is $P=\frac{W}{3^n \quad 1}$.

There are three general classes of inclined planes, the simple inclined plane, the wedge or movable inclined plane, and the screw or revolving inclined plane. There are three general types of simple inclined planes, as illustrated. 1st. That in which the power acts in a direction parallel with the inclined face of the inclined plane. 2d. That in which the power acts parallel with the base of the inclined plane. 3d. That in which the power acts at an angle both to the face and to the base of the inclined plane. The formulæ for determining the mechanical advantage secured by the different forms of inclined planes are given in the illustration. In the third type of inclined plane the relation of power to weight changes as the weight is drawn up the plane, owing to the fact that the angle $B$ becomes gradually larger.

There are two types of wedges, the single wedge and the double wedge. The latter is the more common type.

Under revolving inclined planes we have the screw together with the cam (not illustrated here), which are more commonly used in machinery than any other type of inclined plane.

# CHAPTER III.

## MECHANICAL MOVEMENTS.

### TOOTHED GEAR.

1. Spur Gears.—The ordinary form of toothed-wheel. The smaller of two intermeshing gear-wheels whether a spur- or bevel-wheel is called a Pinion.

2. Gear with Mortised Teeth.—This is what is ordinarily known as a Cog-wheel among machinists. The wheel is ordinarily made of iron and the teeth of wood.

3. Step Gear.—The face of this gear is divided into sections with the teeth of the different sections arranged in steps; that is, one in advance of the other. Step gear-wheels are useful in heavy machinery, as they give a practically continuous bearing between the intermeshing teeth of the gear-wheels.

4. Oblique Toothed Gear.—The teeth are cut diagonally across the working face of the wheel so as to give the gear-wheel a side thrust. In a double oblique toothed-gear, usually called a V-toothed gear, the thrust in one direction is neutralized by an equal thrust in the opposite direction. As in the stepped-gear it gives a continuous bearing of the teeth.

5. Internal or Annular Gear.—The teeth are formed on the inner periphery of a ring. This type of gear is used in heavy machinery, because it offers a greater hold for the teeth of the driving pinion. There is less sliding friction between the teeth than in the usual outside spur-gear and pinion.

6. Star Wheel Gears.—The teeth are so formed as to permit an appreciable separation of the gear-wheels without preventing them from properly meshing one with the other. These gears are used on wringing machines, etc.

7. Elliptical Gears.—Due to their elliptical form, while the driving-gear rotates at constant speed, the other gear will be rotated at a variable speed. That is, its motion will first be accelerated and then retarded. They are used in some machines to produce a slow powerful stroke followed by a quick return.

8. Angular Gears.—These gears have a rectangular form and, as in the elliptical gears, they serve to transform uniform rotary movement into variable rotary movement. However, this movement is more jerky than that produced by elliptical gears. Angular gears are very seldom used.

9. Lantern Gear.—The teeth consist of pins which lie parallel with the axis of the gear-wheel, and are secured at their ends in two disks or gear heads. The pins are so spaced as to mesh with the teeth of a spur-gear. The lantern-gear permits limited sliding movement of the spur-gear along its axis. It can be very cheaply made, but is used chiefly for light work, such as clock mechanism, etc.

10. Crown Gear.—The teeth project perpendicularly from a side face of the wheel instead of lying in the plane of the wheel. When in mesh with the teeth of a spur-gear or a lantern-gear, it forms a cheap method of transmitting power from one shaft to another lying at right angles thereto. Crown gears are useful for light work, and were common in old clock mechanisms. They used to be known as *Contrate* wheels.

11. Bevel Gears.—The ordinary gear for transmitting power from one shaft to another at an angle thereto. When the wheels are of the same size and operate on shafts, lying at an angle of 45 degrees, one with the other, they are called Miter gears.

12. Worm or Screw Gear.—An endless screw engages a spur-gear with spirally disposed teeth. The screw is called a worm, and the spur-gear a worm-wheel. A much diminished but very powerful motion is communicated from the worm to the worm-wheel. It is used in heavy machinery.

13. Curved Worm Gear.—The working face of the worm is curved so that a number of teeth will be in mesh with the worm-wheel, thus giving greater strength. It is a difficult matter to cut the thread of this worm correctly owing to its varying pitch. The gear is called the saw-tooth gear when the teeth and thread are V-shaped, as illustrated.

14. Spiral or Helical Gears.—The teeth are spirally disposed on the working faces of the wheels so that they will transmit motion to shafts lying at right angles one with the other.

15. Skew Gears.—The gears rotate on shafts which lie in different planes and at an angle with each other. The drawing shows a skew spur-gear meshing with a bevel-gear. The same term would apply to two bevel gears lying in different planes and at angles to each other.

16. Rack and Pinion.—A spur-gear engages a toothed bar. Rectilinear motion is by this mechanism transformed to rotary motion or vice versa. It is quite common in heavy machinery to find a worm meshing with and driving a rack.

17. Spherical or Globoid Gear.—A spiral thread is cut on a spherical body and meshes with the spiral teeth of the spur pinion. The latter is so mounted that it may be swung to different positions on the spherical gear, thus varying its speed of rotation.

18. Gear with Roller Teeth.—The teeth project from the flat face of the wheel, and consist of pins carrying rollers. This construction is used to reduce friction.

19. Pin Wheel.—The flat face of the gear is studded with pins which are adapted to

mesh with slots formed in the edge of a pinion. The pinion is so mounted that it can be moved toward or from the center of the pin wheel to vary its speed of rotation. When the pinion is moved past the center of the pin wheel its direction of rotation is reversed.

20. Spiral Hoop Gear.—A spiral thread is formed on the flat face of the wheel and this meshes with a worm-wheel. The latter is moved forward one tooth at each complete rotation of the spiral hoop. This gives a powerful drive, though, of course, at a greatly diminished speed.

21. Intermittent Gear or Geneva Stop.—The driving-wheel is provided with a single tooth adapted to engage one of a series of notches in the other wheel. At each complete rotation of the driving-wheel the other wheel is moved forward one notch but no more, due to the concave space between the notches which fits closely against the circumference of the other wheel. In the Geneva stop one of these spaces is formed with a convex outline, as illustrated. When this space is reached both wheels are prevented from further rotation forward. The Geneva stop is used on watches to prevent winding up the main spring too tightly.

22. Intermittent Bevel Gear or Mutilated Gear.—The teeth are formed only at intervals on the face of the gears. The space between the teeth in the driving-gear is convex, and that between the teeth in the other gear is concave, so that when the teeth are not in mesh with each other these convex and concave portions fit into each other and prevent the driven gear from moving forward under its own momentum.

23. Variable Gears.—The gear wheels are made up of gear sectors of different radial length, which produce suddenly varying motions of the driven gear due to the varying leverage between the wheels. The segments are arranged on different planes so as not to interfere one with the other.

24. Scroll Gears.—The gears have a scroll form which produces a gradually increasing or decreasing speed during each rotation. These gears are also called cam gears.

25. Elliptical Bevel Gears.—They produce variable motion of a shaft lying at right angles to the driving shaft. This gear is used on bicycles to give increased power on the downstroke of the pedal and a quick movement on the return.

26. Variable Pin Wheel.—A cone is provided with pins arranged spirally thereon, and these mesh with teeth formed on the other cone. When one cone is rotated at a constant speed the other moves with a gradually increasing or decreasing speed during each rotation.

27. Cam-toothed Pinion.—The pinion consists of two oppositely disposed heart-shaped teeth, mounted side by side, on a shaft. The gear-wheel with which they mesh has teeth alternately arranged on opposite side faces. Due to the form of the pinion teeth, the gear-wheel is locked after being moved forward by one tooth until the other tooth comes into mesh with a tooth on the other face of the wheel.

28. Bevel Scroll Gear.—The gear-wheel consists of a bevel spiral scroll which meshes with a bevel pinion. As the spiral scroll rotates it causes the pinion to slide forward on its shaft, and thus varies its speed.

## FRICTION GEAR.

29. Flat-faced Friction Gear.—A common type of friction gear. The wheels are usually faced with rubber or leather to increase the frictional hold between the wheels. One of the wheels is journaled in bearings which can be adjusted toward the other wheel so as to increase the frictional engagement.

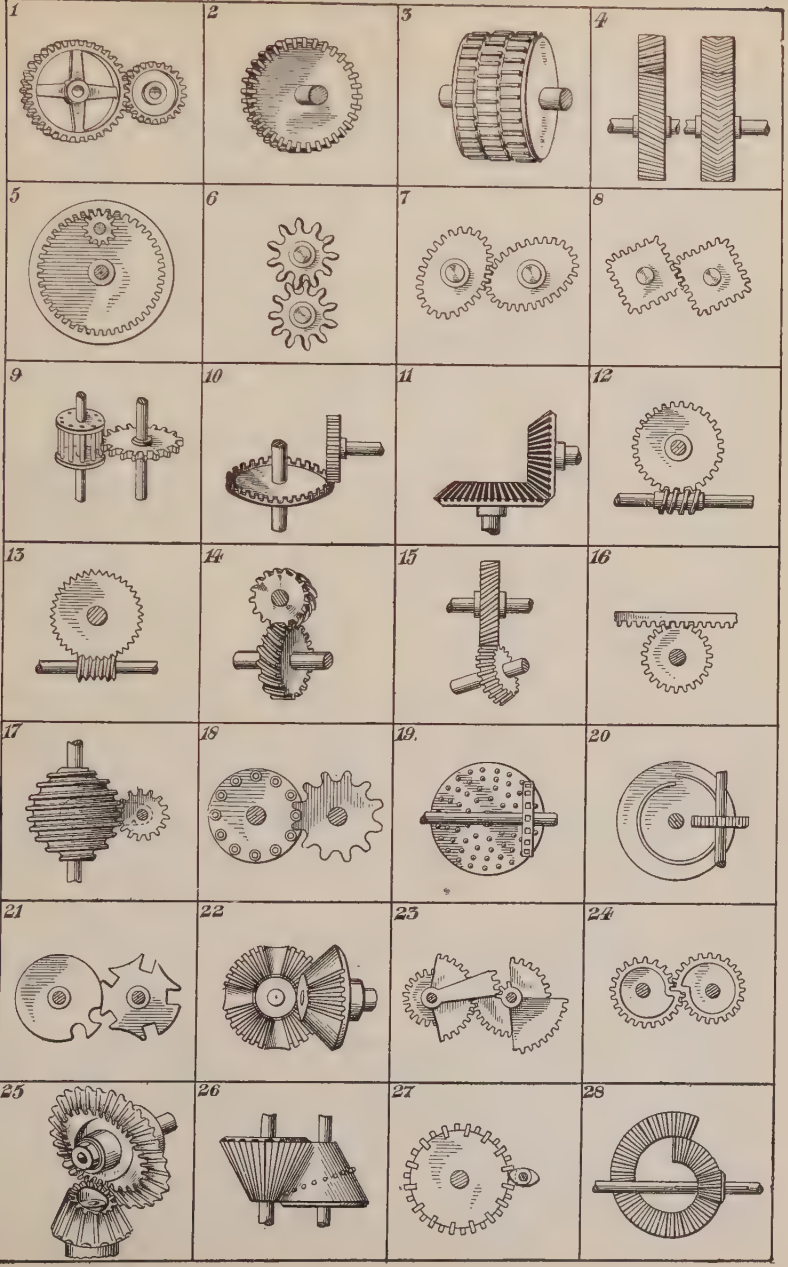
30. Grooved Friction Gear.—The faces of the wheels are grooved so as to increase the bearing surface. The best results are obtained by pressing the wheels but slightly into engagement with each other, as this produces little loss of power by friction.

31. Adjustable Friction Pinion.—The pinion is formed of a disk of rubber or other flexible material held between two washers. When these washers are tightened together they press out the rubber between them, crowding it into closer contact with the V-groove of the gear with which it engages.

32. Beveled Friction Gear.—Two cone frustums are used to convey motion from one shaft to another at right angles thereto.

33. Friction Drums.—The drums have concave faces which permit them to transmit motion one to the other while lying at an acute angle with each other.

34 to 40. Variable Speed Friction Gear.—34, a pinion, engages the flat face of the friction disk. Variable motion is produced by moving the pinion across the face of the disk. When the center of the disk is reached no motion is transmitted. Beyond the center the direction of motion transmitted is reversed. 35. Motion is transmitted from one friction disk to another lying parallel, but not in alignment therewith, through an intermediary pinion. This pinion can be moved vertically to engage different points on the friction disks, and thus produce any desired variation in the speed transmitted. 36. Two convex friction disks are so arranged that one may be swung through an angle bringing different points on its surface into contact with the face of the other disk. In this manner the speed of the motion transmitted is varied. This gear is used on sewing-machines. 37. Two parallel friction disks are each provided with an annular concavity. Motion is transmitted from one disk to the other by a friction pinion mounted between the disks, and so arranged that it can be rotated to engage different points on the surfaces of the concavities, thereby varying the speed transmitted. 38. A cone with concave face is engaged by a pinion which may be swung about a center to engage different points on the face of the cone. 39. Two cones with concave faces are mounted on shafts running at right angles to each other. Motion is transmitted from one cone to the other through a friction pinion mounted to swivel so as to engage different points on the faces of the cones. 40. Two friction cones are mounted on parallel shafts, and between them runs a friction pinion having two faces, one engaging the upper cone and the other engaging the lower cone. This provides a broad bearing surface. The pinion may be moved to different positions along the faces of the cones, and thereby produce changes in the speed.

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## CHAIN GEAR.

41. Sprocket Wheel.—The wheel is provided with teeth adapted to fit in between the links of a chain. The chain may be of the ordinary oval welded link type or of the flat riveted type used on bicycles.

42. Link-belt Wheel.—The chain is made up of square links which are engaged by ratchet-shaped teeth on the chain wheel.

43. Pocket Wheel.—The wheel is formed with pockets into which the links of the chain are adapted to fit.

44. Side-toothed Wheel.—The wheel is formed with two sets of teeth between which the chain travels. The teeth bear against the ends of the outer links of the chain.

45. Side and Center Toothed Chain Wheel.—This wheel is similar to that shown in Fig. 44, but has in addition a row of teeth along the center which bear against the center link of the chain.

46. Toothed-link Chain and Wheel.—The links are formed with projecting teeth which fit into notches on the rim of the chain wheel.

47. "Silent" Chain and Wheel.—This is a special type of chain in which each link is formed with a tooth at each end. The teeth of adjacent links coact to completely fill the spaces between the teeth of the chain wheel. The construction is such as to produce a noiseless operation of the chain gear even at high speeds.

48. Detachable Toothed-link Belt and Wheel.—Each link is formed with a tooth, which meshes with the teeth of the chain wheel. The construction of each link is such that it may be readily slipped into or out of engagement with the next link of the chain.

## ROPE GEAR.

49. V-Pulley.—The ordinary type of pulley for round ropes or cables. Owing to the V-shaped construction of the pulley groove, the rope wedges tightly into engagement with the pulley.

50. Pulley with Flexible Filling.—In order to secure frictional engagement of the cable with this pulley, the pulley groove is provided with rubber, leather, wooden, or other filling.

51. Pulley with Ribbed Groove.—In this construction of pulley the required grip is produced by forming ribs in the bottom of a pulley groove.

52. Pulley with Gripping Lugs.—The flanges of this pulley are formed with lugs which kink the rope or cable as shown, thus producing the required grip.

53. Rope Sprocket-wheel.—An old form of rope gear used in hoists and the like.

54 and 55. Gripping Pulleys.—Gripping arms are provided which grip the cable at the point where the cable presses into the pulley. In 54 the gripping arms are wedged inward by the side walls of the pulley groove when pressed downward by the cable. These arms are normally h ld up by coil springs. In 55 the cable is gripped by the toggle movement of hinged clips placed at intervals along the periphery of the pulley.

56. Cable Sprocket-wheel.—The cable is provided with clamps which enter sockets formed in the cable wheel. This is a form of cable gear commonly used at present in elevating and conveying machinery.

## CLUTCHES.

57. Common Jaw Clutch.—One member of the clutch is mounted to slide on a feathered shaft, and the other member which is connected with the machinery is normally stationary on this shaft. When the slidable member is moved forward the teeth on its forward edge intermesh with the teeth of the other member, setting the machinery in motion. The slidable member is moved forward by means of a forked lever which is hinged to a split collar mounted loosely between flanges on the clutch member.

58. Claw Clutch.—The slidable member of the clutch consists of a body portion with two claw arms which, when moved forward, are adapted to engage opposite sides of a bar on the other member of the clutch.

59. Lever Clutch.—The slidable member is provided with a lever loosely hinged to its forward end. The other member of the clutch consists of a disk formed with ratchet teeth on its face. These are engaged by the hinged arm when the shaft rotates in one direction, but the arm moves freely over them when rotated in the opposite direction.

60. Knee and Rose Clutch.—A crank arm is attached to the slidable member of the clutch, and engages a pin on an arm loosely hinged to the opposite member of the clutch.

61. Ratchet Clutch.—The clutch members are formed with ratchet teeth, so that when the motion of the driving shaft is reversed, the members will be disengaged.

62. Pin Clutch.—The slidable member is provided with radial arms formed with pins at their outer ends which are adapted to enter sockets formed along the periphery of a disk on the opposite member of the clutch.

63. Friction Disk Clutch.—The two clutch members are each formed with disks preferably faced with rubber or leather, so that when pressed together their frictional engagement will cause a transmission of motion from the rotating disk to the other.

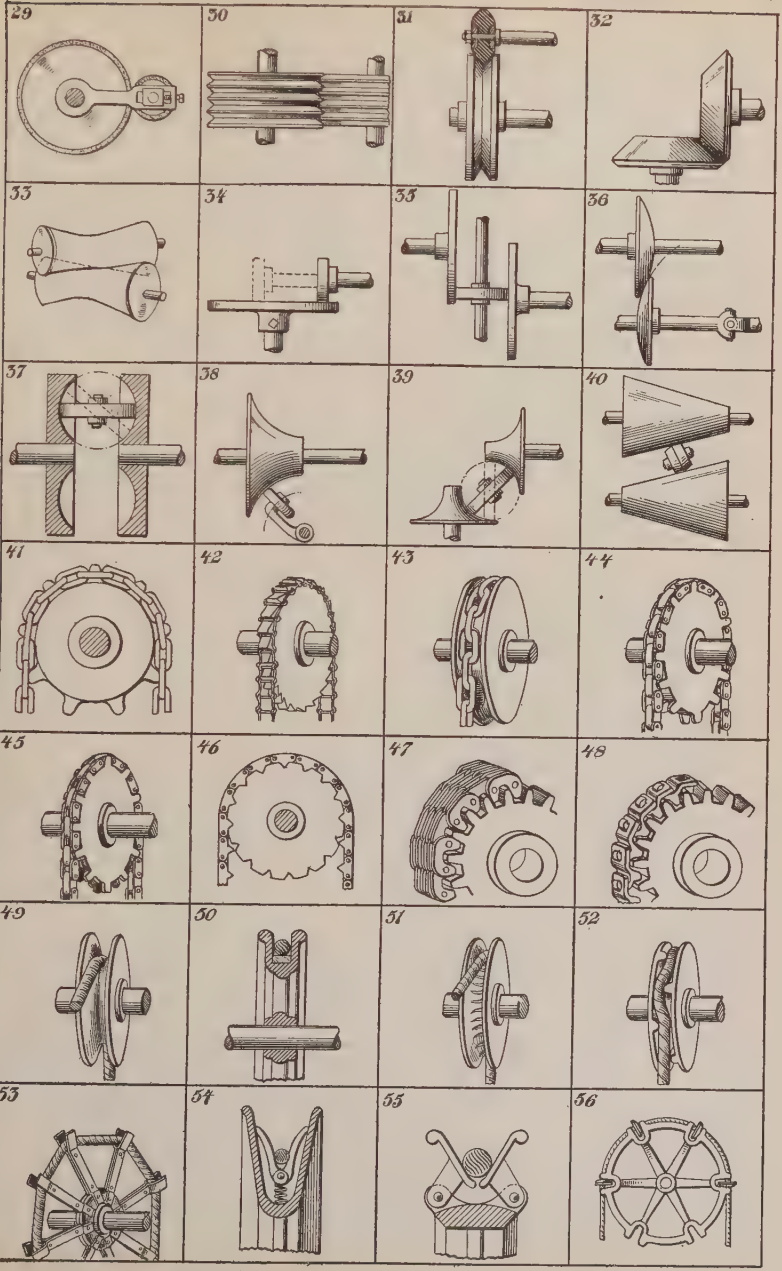
64. Friction Groove Clutch.—One of the clutch members is formed with a groove in its face to receive the lip of the other member which is cup-shaped. Both the lip and the side walls of the groove are slightly tapered to insure a close fit, even after the parts have been partly worn away by friction.

65. Stud Clutch.—Engagement between the two members of the clutch is effected by means of a stud on each disk adapted to enter a notch formed in the periphery of the opposing disk.

66. Friction Band Clutch.—One member of the clutch consists of a pulley provided with a steel band which encircles and fits tightly on its periphery. The other member of the clutch consists of a lever provided with pins at its outer ends, which are adapted to engage the steel band. Since this band is not fastened to the pulley, any shock due to suddenly throwing the clutch members into engagement will be taken up by the steel band slipping on the face of the pulley.

67. Friction Cone Clutch.—The clutch is made up of two cones, one adapted to fit into the other. The frictional engagement causes one to drive the other.

68. Self-releasing Clutch.—The clutch disks are provided with inclined teeth, so that in case the resistance to the driven shaft in-

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creases beyond a certain degree, the clutch members will automatically move apart.

69. Cam Clutch.—One of the members is cup shaped, and within this the other member operates. The latter comprises a number of cam-shaped arms hinged to a body portion, and so arranged that when moved in one direction they will bind against the inner wall of the drum, but when moved in the opposite direction they will be automatically disengaged therefrom.

70. V-grooved Clutch.—The clutch disks are formed with annular V-grooves adapted to fit into each other, and thus increase the friction surface of the clutch members.

71. Expansion Clutch. — The slidable member is provided with a number of movable ring segments connected by radial arms to the main body of the clutch and adapted to bear against the inner surface of the drum or cup which constitutes the other member of the clutch. When the slidable member is moved forward, by reason of the toggle action of the radial arms, the segments are brought into frictional engagement with the other member of the clutch.

72. Coil-grip Clutch. — The movable member of the clutch is formed with a number of coils of steel in which there is a central conical opening. This is moved over the cone which constitutes the opposite member of the clutch, producing the required frictional engagement of the two members.

## ANGLE SHAFT COUPLINGS AND UNIVERSAL JOINTS.

73. Crank and Hinged-pin Coupling.—A coupling for shafts which lie at an angle to each other. One shaft carries a hinged pin which fits into an opening in the outer end of a crank arm carried by the other shaft.

74. Double-sleeve Angle Coupling.—Each shaft carries a crank arm provided with a pin at its outer end, which lies parallel with its respective shaft. The two pins enter a coupling device consisting of two sleeves integrally formed, but lying at an angle with each other which corresponds to the angle formed by the shafts. Through this double-sleeve coupling, motion is transmitted from one shaft to the other, the pins sliding back and forth in the sleeve openings.

75. Cross-bar Angle Coupling.—This is used for coupling two parallel but offset shafts. Each shaft carries a yoke piece provided with sleeves at its outer ends. The coupling member is a cross-shaped piece, its arms fitting into the sleeves of the yoke pieces, and permitting the necessary lateral play as the shaft rotates. This form of coupling is also applicable to shafts which lie at an angle with each other.

76. Pin and Slot Coupling.—A crank pin carried by one shaft engages a slot in a crank arm carried by the other shaft. The motion transmitted is variable, due to the fact that the leverage varies as the pin moves up and down in the slot.

77. Ring-Gimbal Universal Joint.—The ends of the shafts are provided with yoke members whose arms are pivoted to a ring-gimbal, the pivot pins of the two yoke pieces lying at right angles to each other. This coupling will communicate motion at any angle under 45 degs. For angles of over 45 degs. a double-link universal joint is used.

78. Double-link Universal Joint.—A link forked at each end is hinged to two rings, which are mounted in the yoke pieces on the ends of the shafts. In place of rings cross pieces such as shown in the illustration are often used.

79. Hooke's Angular Coupling.—The shafts are connected by two double links which are arranged in the form of a parallelogram. Intermediate of the shafts the links are connected with ball-and-socket joints.

80. Ball-and-socket Universal Joint.—Socket pieces are secured to the ends of the shafts, and these are provided with metal bands which encircle the ball that constitutes the coupling member. The bands enter grooves in the ball which lie at right angles to each other.

81. "Almond" Angular Coupling.—A side view of the coupling is shown at 1 and a plan view at 2. Between the shafts to be coupled is a fixed stud on which a bell crank is mounted to turn. The bell crank is permitted to slide axially on the stud. The bell crank is connected at the ends by ball-and-socket joints with links attached to the ends of the shafts. Now, as the power shaft rotates, rotary motion will be communicated to the other shaft through the bell crank, which will rock and also slide axially on the stud.

82. Flexible Shaft.—Two shafts are connected by a flexible shaft consisting of a coil spring, or a metal tube in which a helical saw-slot has been cut. This flexible shaft will permit transmission of motion through a wide angular range.

83. Linked Flexible Shaft.—The flexible shaft is made up of a series of links coupled together with universal joints. A coil spring fits loosely over the links and prevents them from kinking. This spring in turn is covered with a flexible tube. The shaft will transmit motion about almost any curve or angle. It can be used for heavy work.

84. Right-angle Coupling.—The ends of the shafts are formed with heads in which are drilled a number of sockets. A series of rods, each bent to form a right angle, enter these slots and form the coupling links between the shafts. As the shafts rotate these rods slide in and out of their sockets.

## RATCHET MOVEMENTS.

85. The teeth of a ratchet wheel are engaged by a pawl hinged to a rocking arm. The ratchet wheel is rotated only on the forward stroke of the arm.

86. A rocking lever carries two pawls, one on each side of its fulcrum. The wheel is rotated both by the downward and the return stroke of the lever; for while one pawl is rotating the wheel, the other swings to position to take a new hold on the ratchet wheel. The rotation of the ratchet wheel is thus kept nearly constant.

87. A ratchet crown-wheel or rag-wheel is engaged by pawls depending from two arms loosely pivoted on the axle of the ratchet-wheel. These two arms are connected by links to a common power arm. Rectilinear reciprocating movement of the latter in the line of the arrow produces an almost constant rotation of the ratchet-wheel.

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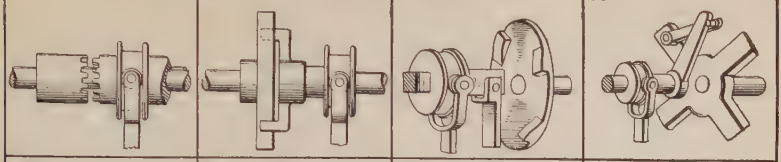

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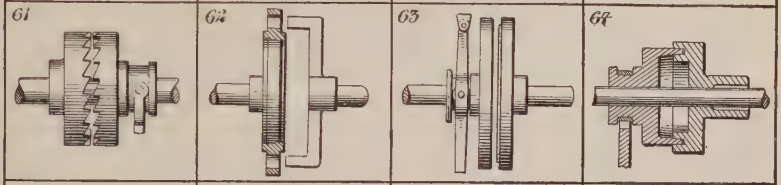

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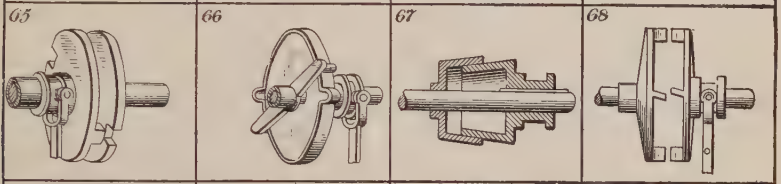

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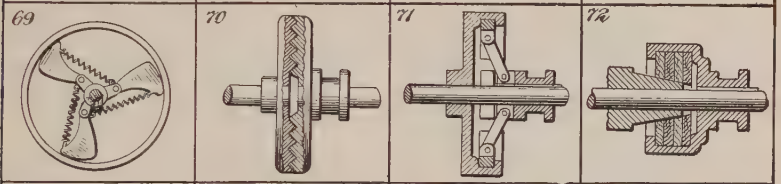

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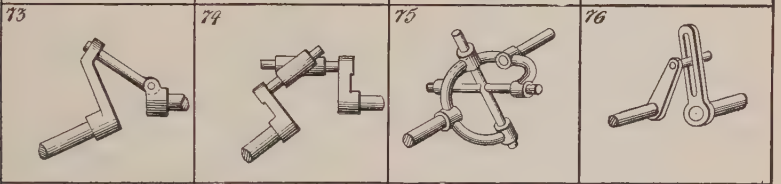

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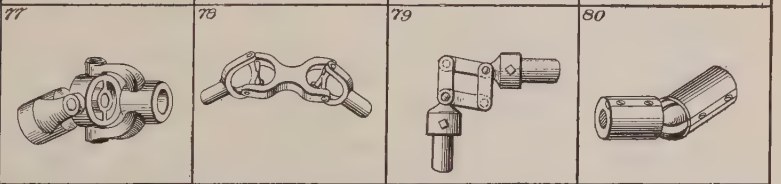

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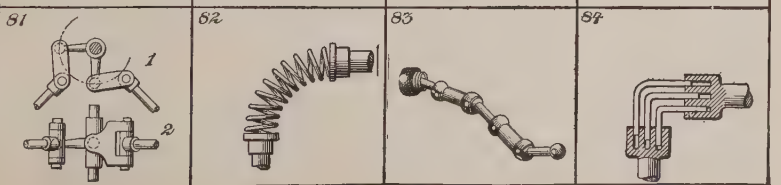


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88. The action of this ratchet mechanism is very similar to that shown in Fig. 86, except that the pawls are hooked and ratchet-wheel is rotated by an alternating pulling rather than pushing action of the pawls.

89. This is a modification of the principle pictured in Fig. 88, and shows a rocking lever with two pawls hinged thereon engaging a ratchet rack.

90. Another modification of the principle shown in 88. The rocking lever is mounted on a fixed stud and is provided at the center with a pin which enters a slot in a ratchet bar. The latter is formed with ratchet teeth on its opposite edges which are engaged by hooked pawls pivoted on the rocking lever. These pawls are crossed, as shown, so that they will be kept by gravity in constant engagement with the ratchet teeth. Now, when the lever is rocked the pawls will alternately act to lift the ratchet bar.

91. A common construction used for rotating a ratchet-wheel against a spring resistance. A dog mounted on a fixed pivot drops by gravity or by spring pressure against the ratchet teeth and holds the wheel from turning while the pawl is being swung back for a fresh hold on the ratchet-wheel.

92. This shows the method of rotating an ordinary spur gear-wheel by means of a pawl. The pawl is provided with a tooth at its outer end which fits between the teeth of the gear. The pawl is hinged to the lower arm of the bell-crank lever mounted on the gear shaft. The operating lever also mounted on this shaft is permitted a certain amount of play between two pins on the shorter arm of the bell crank-lever. A rod connects the operating lever with the pawl. When the lever is raised it first lifts the pawl out of engagement with the gear, then, coming in contact with the upper pin on the bell crank-lever, it moves the pawl and bell crank back to the desired position. On lowering the operating lever the pawl is first brought into engagement with the gear and then the lower pin on the bell crank is encountered, and the gear is caused to rotate. This arrangement prevents wearing away of the teeth—a common defect in the ordinary type of ratchet mechanism.

93. The pawl is kept in contact with the ratchet-wheel by the weight of the lever on which it is formed. By pulling the rope attached to the end of the lever the pawl will be drawn out of engagement with the ratchet-wheel, and the latter will be turned by friction of the rope on the wheel hub.

94. A reversible spur-gear ratchet mechanism. Mounted on the shaft which carries the spur-gear is a bell crank-lever. This at one end carries a double-toothed pawl, one of which teeth meshes with the teeth of the gear. The pawl is so shaped that it will withdraw the tooth from engagement with the gear teeth on the return stroke of the lever. When it is desired to reverse the direction of rotation, the pawl is moved over to the position shown in dotted lines, bringing its other tooth into engagement with the gear teeth.

95. The ratchet-wheel is intermittently rotated by the oscillation of a lever which carries a spring-pressed pawl. On the upward stroke the ratchet is turned by the pawl which is backed by a shoulder on the lever. On the return stroke a dog holds the ratchet-wheel from turning while the pawl snaps past.

96. Ratchet teeth are formed on a ball which rests in a socket formed at the end of a lever. A spring pawl on this lever engages the ratchet teeth at any position of the lever. This construction is useful for ratchet braces which have to be operated in inconvenient places.

97. A device for converting rotary motion into vibratory motion. A spring-pressed pin engages the teeth of a revolving crown-wheel ratchet, and is thereby caused to vibrate.

98. A device for converting reciprocating motion into intermittent rotary motion. The crown-wheel ratchet is intermittently rotated by a reciprocating lever carrying a pawl which engages the ratchet teeth.

99. Internal ratchet used on ratchet braces, etc. The drill spindle carries a number of spring-pressed pawls which bear against the internal ratchet teeth formed in the handle of the brace.

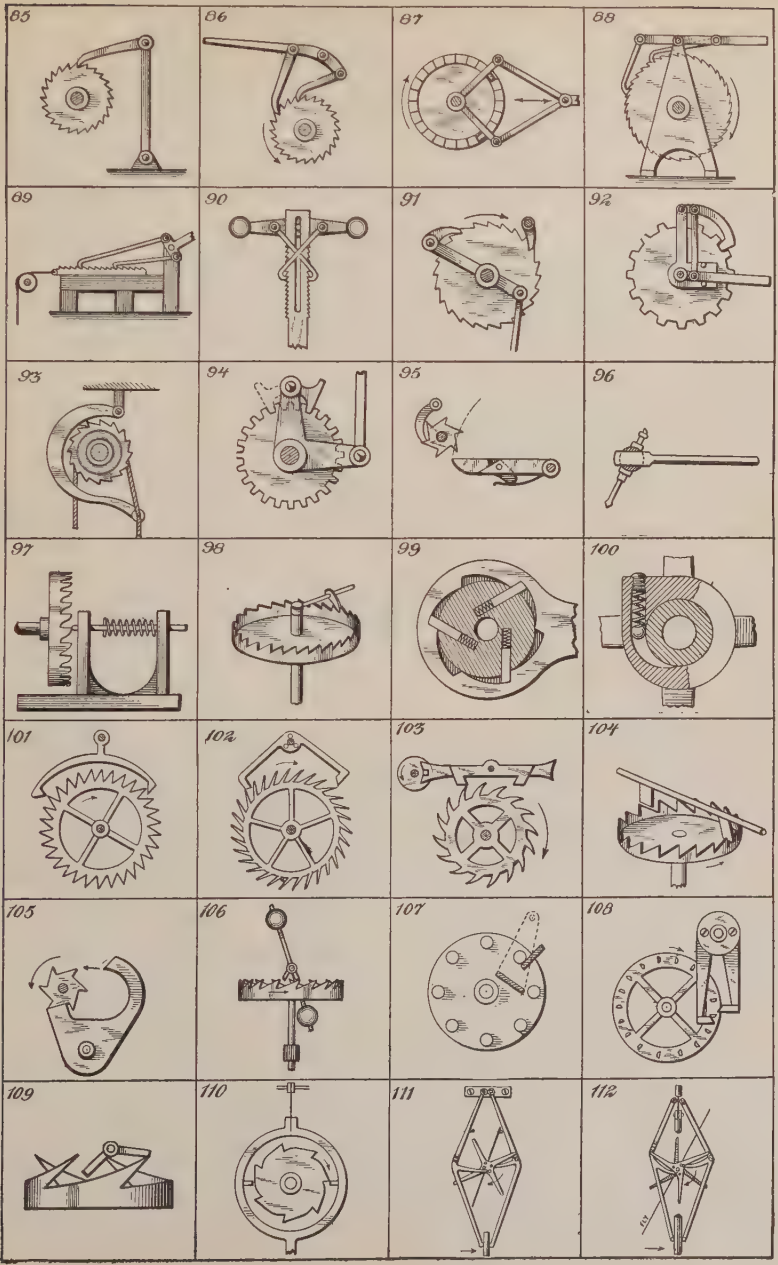
100. Ball ratchet device for lawn mowers, etc. In the hub of a wheel is a groove in which a ball is carried. A spring presses this ball down against a shaft on which the wheel turns. When the wheel rotates forward, the ball wedges in between the shaft and the groove, causing the shaft to turn with the wheel. When the direction of rotation is reversed, the ball is forced up against the spring, releasing the shaft.

## ESCAPEMENTS.

101. Recoil Escapement.—This is a common form of escapement used on clocks. The pallets carried by the pendulum are so mounted that when a tooth of the escape wheel, which is driven by the clock-train, is just escaping from one of the pallets, another tooth falls on the other pallet near its point. As the pendulum swings on, however, the taper face of the pallet bearing against the tooth causes the escape wheel to turn slightly backward. As the pendulum swings back, it receives an impulse from the escape wheel which is greater by reason of this recoil. The principal value of the recoil, however, is to overcome any unevenness in the pressure exerted by the train, which might otherwise stop the clock.

102. Dead-beat Escapement.—A form of escapement used on the best clocks. The teeth of the escape wheel fall "dead" upon the pallets, that is, the pallets are so cut that as the pendulum continues to swing they slide on the teeth without turning the escape wheel backward. The ends of the pallets are formed with inclined faces, termed "impulse faces," against which the teeth of the escape wheel bear when giving impulse to the pendulum. The value of this escapement lies in the fact that it gives a very even beat of the pendulum even when there is a slight variation in the force exerted by the clock train.

103. Lever Escapement.—This is an escapement used on watches. The anchor on which the pallets are carried is secured to a lever, formed with a notch in one end. This notch is engaged by a pin on the arbor of the balance wheel. The teeth of the escape wheel alternately bear against the inclined faces of

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the pallets and oscillate the lever, which turns the balance wheel alternately in opposite directions.

104. Verge Escapement.—A form of escapement used in old-fashioned watches. The escape wheel is a crown wheel, and its teeth, on opposite sides, are engaged by two pallets, carried on the shaft of the balance wheel. The escapement teeth, acting alternately on the pallets, lift and clear them, thus rocking the shaft and balance wheel, which governs the frequency of the escape.

105. Star Wheel Escapement.—The escape has but few teeth and is, therefore, called a star wheel. The pallets act on teeth that lie diametrically opposite each other. This escapement has a dead-beat action.

106. Crown Tooth Escapement.—An old form of recoil escapement, in which a crown escape wheel is used. The pallets are mounted to engage opposite sides of the wheel. This type is objectionable, owing to the fact that the pendulum must oscillate through a very wide angle in order to permit the teeth to escape from the pallets, which requires a greater pressure in the clock-train and heavier parts and produces greater friction on the pallets.

107. Lantern Wheel Escapement.—An old-fashioned type of escapement, in which the escape wheel is a lantern wheel, and the pallets are two plates set at angles on a rocking arm.

108. Pin-wheel Escapement.—A dead-beat escapement used in many of the best turret clocks. The escape wheel is formed with pins which drop on to the "dead" faces of the pallets, but give impulses to the pendulum by sliding off the inclined "impulse" faces of the pallets. It is found best in practice to cut the "dead" faces so as to give a very slight recoil.

109. Old-fashioned Crown Wheel Escapement.—This, in appearance, is quite similar to the escapement shown in Figure 106, but is different in action. The inclined faces of the teeth, which are very long, act to lift the pallets.

110. Ring Escapement.—A form of "dead-beat" escapement. The pallets are formed on the inside of the ring, within which the escape wheel turns.

111 and 112. Gravity Escapements.—A type of escapement in which the impulse from the escape wheel is not given directly to the pendulum, but through the medium of two weights, usually the arms on which the pallets are carried and which are alternately lifted by the escape wheel and dropped against the pendulum. Figure 111 shows the four-legged gravity escapement used on turret clocks. The escape wheel is formed with four legs or teeth, and carries eight pins, four on one face of the hub and four on the other. The pallet arms are pivoted as near as possible to the point from which the pendulum swings. The pallets which are formed on these arms are arranged to lie one on one side and the other on the other side of the escape wheel. The pallet arms are each provided with a stop piece against which the teeth of the escapement will alternately rest. In the illustration, a tooth of the escape wheel is resting against the stop on the right-hand arm. As the pendulum swings toward the right, the tooth will escape from the stop, permitting the wheel to rotate until it encounters the stop on the left-hand arm, at the same time a pin on the wheel engages the end of the pallet at the left, and lifts the pallet arm. In the meantime the right-hand pallet arm swings with the pendulum to the end of its stroke, but falls with it on the return stroke until stopped by a pin on the escape wheel. It will be evident that the angle through which the pallet arm falls with the pendulum is greater than that through which it is lifted by the pendulum, and it is this difference in travel which gives impulse to the pendulum. Figure 112 shows a double, three-legged escapement which is used for very large clocks. Two three-legged escape wheels are used with three lifting pins held between them like the pins of a lantern wheel. The pallets operate between the wheels. A stop piece is placed on one of the pallet arms for the forward wheel, and the other arm carries a stop for the rear wheel. The teeth of one wheel are set 60 degrees in advance of the other. The action is similar to that of the four-legged escapement. A tooth of the forward wheel is shown resting on its stop. When this is released by the swinging pendulum, the wheels rotate, lifting the left-hand pallet until a tooth of the rear wheel engages its stop. The right pallet arm, however, continues to be lifted by the pendulum, and then falls with it, giving it impulse until arrested by a lifting pin, only to be lifted again when the pendulum releases the rear wheel from its stop.

## GEARING.

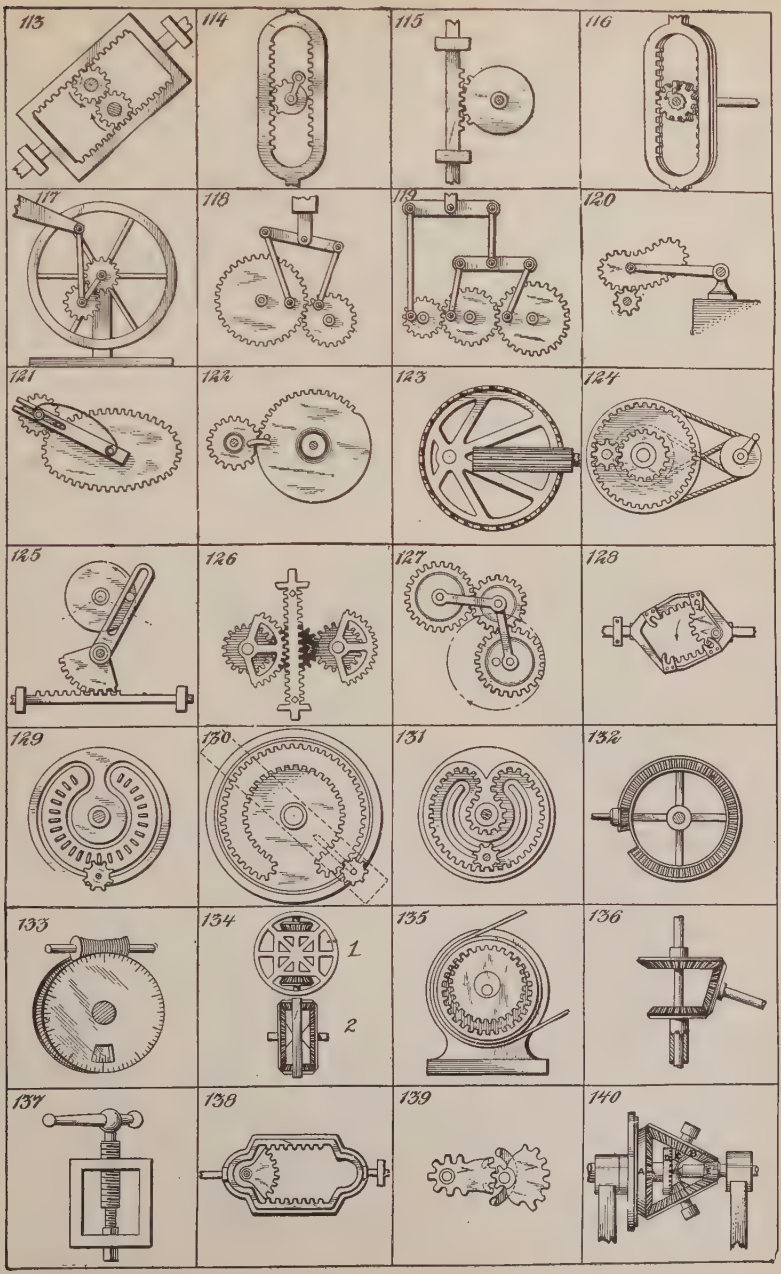
113. A means for changing rectilinear reciprocating motion to rotary reciprocating motion and vice versa. Two intermeshing pinions engage internal racks formed on opposite sides of a frame.

114. Means for changing rotary motion to rectilinear reciprocating motion. A rotating sector or pinion formed with teeth on only a portion of its periphery imparts reciprocating motion to a rack frame by first engaging the teeth at one side of the rack, and then the teeth on the other side of the rack. See Figure 115 for gravity return.

115. Another method of converting rotary motion into rectilinear reciprocating motion. A rotating sector engages the teeth of a rack during a part of its rotation and thereby lifts the rack, but as soon as the rack clears the sector teeth, it drops by gravity, ready to be lifted up when it again encounters the teeth of the sector. See Figure 114 for power return.

116 A movement designed as a substitute for a crank. The rack frame is formed with internal racks on opposite sides, but these racks lie in different planes. Two separate pinions are employed which mesh respectively with these racks. The pinions are mounted loosely on a shaft, but carry pawls which engage with ratchet wheels secured to the shaft. On the forward stroke of the rack frame the pinions will both be rotated but in opposite directions. However, due to their ratchet and pawl connection with the shaft, only one pinion turns the shaft. On the return stroke the rotation of the pinions will be reversed but the shaft will continue to rotate in the same direction, driven this time by the other pinion of the pair.

117. Sun and Planet gearing. A gear wheel, called the "sun" wheel, rotating on a fixed center, is engaged by a gear wheel called

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the planet wheel, which revolves about the sun wheel. This construction was used by James Watt in one of his steam engines as a substitute for a crank. The planet wheel was rigidly secured to the connecting rod and connected by an arm to the center of the sun wheel. At each complete revolution of the planet wheel about the sun wheel, the latter was caused to rotate twice.

118 and 119. Means for converting rotary motion into irregular reciprocal motion. In 118 two intermeshing spur gears are provided with crank arms connected by a working beam. If the gears are of equal size the motion transmitted to the rod secured to the working beam will be uniform. If, however, the gears are of different sizes, the motion of this rod will vary greatly. In 119 a still more complex movement is produced, since there are three intermeshing gear wheels of unequal sizes and two connected working beams.

120. Irregular oscillatory motion is given to a hinged arm by pivoting at its outer end a cam-shaped gear wheel which is rotated by a continuously driven pinion. Any desired motion of the arm may be produced by varying the shape of the cam gear.

121. Means for converting uniform rotary motion into variable rotary motion. An elliptical gear rotates at uniform speed and drives a spur pinion. The latter is secured to a shaft which slides between the arms of two forked levers. A spring keeps the pinion in mesh with the elliptical gear.

122. Means for converting constant rotary motion into intermittent rotary motion. The driving wheel is formed with teeth through a portion of its periphery equal to the toothed periphery of the pinion. The latter is cut away at one place to fit the plane portion of the driving wheel. This prevents the pinion from rotating until a pin on the wheel strikes a projecting arm on the pinion and guides the teeth of the gears into mesh with each other.

123. Means for converting uniform rotary motion into variable rotary motion. A crown wheel eccentrically mounted is driven by a pinion rotating at uniform speed. The point of engagement of the crown wheel with the pinion varies radially, causing the wheel to rotate at a variable speed.

124. The mechanism is so arranged as to impart planetary movement to a pinion. An internal gear wheel formed with a pulley groove in its periphery is mounted to rotate on a sleeve which carries a spur gear at one end and a pulley at the other. The gear wheels are belted to a driving pulley in such manner as to rotate in opposite directions. A spur pinion which fits in between the teeth of the two gears is rotated thereby on its own axis and revolves about the center of the two gears at a speed which is the differential of the speeds of the two gears.

125. The construction here shown is adapted to produce a slow forward movement of a rack with a quick return. The rack is mounted to slide longitudinally and is driven by a toothed sector. The latter is provided with a slotted arm which is engaged by a pin on a rotating disk. The forward movement will take place while the pin is passing through the larger arc subtended by the two dotted radial lines shown, and there turn while the pin is passing through the smaller arc.

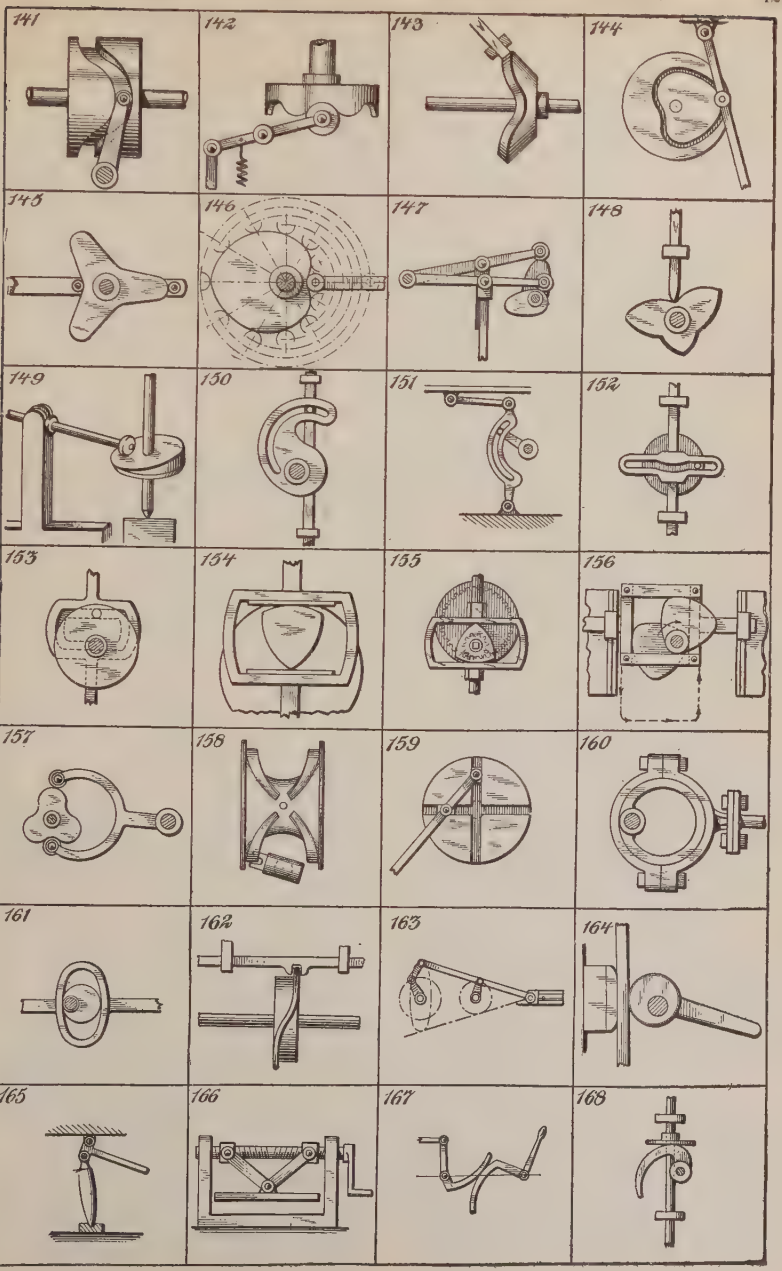
126. A means for converting reciprocating motion into continuous rotary motion. A double-faced reciprocating rack engages first one and then the other of a pair of toothed sectors. The sectors are mounted on a pair of shafts, disposed on opposite sides of the rack. The shafts carry pinions which engage opposite sides of the central gear wheel. The rotary motion alternately imparted to the sectors, is conveyed through these pinions to the gear wheel, each pinion alternately acting to drive the wheel when its respective sector is in mesh with the rack, and then to be driven by the gear wheel until its sector is brought again in mesh with the rack. Thus a continuous rotary motion is produced.

127 Mechanism for converting uniform rotary motion into irregular rotary motion. Mounted eccentrically on the driving shaft is a gear wheel which transmits motion to another gear wheel through an intermediate pinion. Pivoted to the centers of the two gear wheels are two links whose outer ends are connected by a hinge pin on which the pinion rotates. These links serve to hold the pinion constantly in mesh with the gears, no matter what the position of the eccentric is.

128. Means for converting uniform rotary motion into variable reciprocating motion. A rack frame mounted to slide longitudinally is driven by an eccentric-toothed sector. The racks are placed at an angle with the line of movement and are provided with jaws at each end adapted to mesh with pins projecting above the face of the sector. As the sector rotates it transmits a gradually accelerated longitudinal movement to the rack frame until the outer pin engages the jaw at the end of the rack. The rack frame is then driven by this pin until the opposite rack is engaged by the sector teeth.

129 to 132. MANGLE GEARS.—So-called because of their use on mangle machines. 129. The larger wheel is formed with a cam groove which guides the pinion. The shaft of the latter is ordinarily provided with a universal joint, which permits it to move vertically and thus keep in mesh with the crown teeth formed on the large wheel. The pinion meshes first with the outer and then with the inner ends of the teeth on the larger gear, driving the latter first in one direction and then in the other. 130 shows another form of the same movement. The pinion moves radially in the slot shown in dotted lines, and engages first the outer and then the inner line of teeth on the mangle wheel, causing the latter to rotate first in one direction and then in the other. 131. The mangle wheel is formed with an internal gear, and the pinion is guided by a cam groove. This construction and that shown in Figure 130 produce uniform motion through an almost complete rotation, and this is followed by a quick return due to the smaller radius of the inner circle of teeth. 132. In this construction, as in that of Figure 129, the same speed is maintained in both directions of rotation. The mangle wheel in Figure 132 is formed with teeth on both faces; the pinion first engages the teeth on one face of the wheel, and then passing through the opening engages the teeth on the opposite face, thus reversing the direction of rotation.

133 to 137. DIFFERENTIAL GEAR.—133. Two worm wheels, one of which has more teeth than the other, engage a single worm. Suppose that one wheel has 100 teeth and the other has 101; then at every complete rota-

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tion of the latter wheel it will be one tooth behind the former wheel, and at the end of 100 rotations the former would have made a complete rotation relative to the latter. If the worm be cut with a single thread it would have to make 100 times 101, or 10,100 rotations in order to produce this result. This construction is used on certain counting devices. 134. Two bevel gears are connected by a pair of small bevel pinions mounted in a frame, as shown in the side elevation 1. If the gear wheels should be rotated at different velocities the frame would rotate at the mean velocity. 135. A rapidly rotating shaft carries a gear wheel eccentrically mounted thereon. The latter is carried along into engagement with a fixed internal gear or rack, and is thereby rotated at a slow speed. 136. Two concentrically mounted bevel gears of different diameters engage with a third bevel gear. The latter rotates at the mean of the velocities of the other two. 137. A hollow screw threaded into a frame is formed with an internal thread, of slightly different pitch, adapted to receive a smaller screw, which is so mounted in the frame that it may slide longitudinally, but cannot rotate. If the larger screw should have ten threads to the inch, and the smaller screw eleven, the latter would move outward one-eleventh part of an inch while the former was fed inward an inch.

138. Uniform rotary motion converted into reciprocating rectilinear motion. A rack frame arranged to slide longitudinally is engaged by a toothed sector which meshes with the teeth on one side of the rack to drive the frame forward, and then with the teeth on the other side to drive the frame back.

139. Variable speed gear for producing fast and slow motion. It comprises two pairs of toothed sectors so arranged as to properly mesh with each other. The driving gear shown at the right is provided with two arms which carry studs at their outer ends. These studs lie below the lower face of the gears and engage studs formed on the lower face of the driven gear, as shown in dotted lines, thus guiding the wheels after one pair of sectors have moved out of mesh and before the other pair have come into mesh with each other.

140. Mechanism for producing increased or decreased speed on the same line of shafting. A fixed bevel gear wheel, *A*, meshes with two bevel gear wheels, *B*, which in turn mesh with a pinion, *E*, carried on the right-hand shaft. The bevel wheels, *B*, are mounted in a bracket which turns freely on the shaft of pinion, *E*. Each wheel, *B*, carries a pinion, *C*, which meshes with a bevel gear wheel, *D*, carried by the left-hand shaft. The change of speed from one shaft to the other is due to the planetary movement of the wheels, *B* and *C*. When the multiple of the teeth in *A* and *C* exceeds that of *B* and *D* the shafts will rotate in opposite directions.

## CAMS AND CAM MOVEMENTS.

141 and 142. Cylinder or Drum Cams.—In Figure 141 a groove is formed in the curved face of a cylinder or drum. A roller on the end of a pivoted arm fits into this groove. As the drum rotates the arm will be swung to various positions, guided by the groove in the cam. In Figure 142 the roller bears against the rim of the cylinder, which is made of such shape as to give the desired motion to the lever. In this form of cam, while the roller is positively moved down by the cam rim, it is raised up by a spring on the lever, which tends to hold it constantly against the cam. In the first type of cam the motion is positive in both directions.

143. Beveled Cam.—This form of cam is used to give motion to a lever whose axis lies at an angle with the cam-shaft. The cam is of conical form with curved edges against which the lever bears. In our illustration we have shown a sliding rod in place of a rocking lever. The conical face, it will readily be seen, must lie parallel with the plane of the rod.

144. Face Cam.—The cam groove is cut in the face of a disk, and this on being rotated guides the movement of the rocking lever which carries a roller that enters this groove.

145. Clover-leaf Cam.—This is a form of disk cam which gives a positive drive to a sliding lever. The cam acts between two rollers on the lever, and is so cut as to exactly fill the space between these rollers at all times.

146. Heart Cam.—Another form of disk cam. This is so cut as to give uniform rectilinear motion to a sliding rod which bears against its edge. To lay out this cam, divide the desired line of travel of the rod into any convenient number of equal spaces, starting from the center of the roller, and from the center of the cam describe arcs passing through the dividing points. Twice the number of radial lines should be laid off from the center of the cam, the lines being equally spaced angularly. The successive points of intersection of the radial lines and the arcs will then mark the centers for a series of arcs with radii equivalent to the radius of the roller. The curve drawn tangent to these arcs will then mark the outline of the cam.

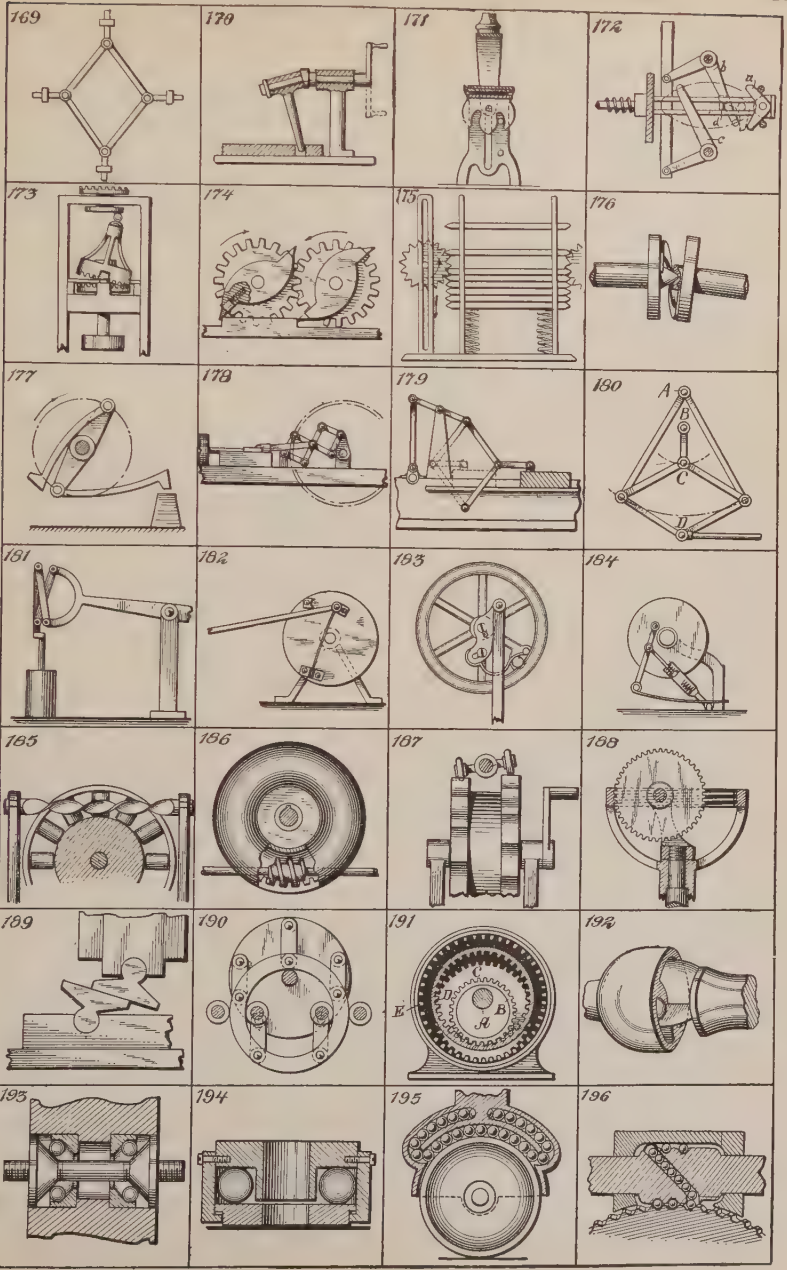
147. Means are here shown for converting rotary motion into alternating reciprocating motion of two rods. The rods are attached to pivoted levers carrying rollers which bear against the edges of two oval disk cams mounted on a rotating shaft.

148. Rotary motion is here converted into variable rectilinear motion. The end of a sliding lever rests on the irregular edge of a disk cam, and is there by caused to move up and down following the irregularities of the cam. The cam shown gives three reciprocations of the rod for each rotation of the cam shaft.

149. Means for converting rotary motion of a shaft into rocking motion of a lever. The lever is caused to rock by a cam with an oblique face on which the roller of the lever bears. This is a modification of the motion shown in Figure 142.

150. Means for converting rocking motion of a shaft into uniform rectilinear motion of a rod. The rod, which is mounted to slide in bearings, carries a pin which engages a slot in the cam on the rocking shaft. The cam slot is so cut as to give uniform motion to the rod.

151. Continuous rotary motion of a shaft is here converted into intermittent reciprocating motion of a slide. A cam lever hinged at its lower end to a fixed point is connected by a rod at its upper end, to the slide. A crank arm on the rotating shaft carries a pin which enters a curved slot in the cam lever. The crank arm causes the lever to rock, carrying the slide with it. The cam slot should form an arc with a radius equal to that of the crank arm, so that while the crank pin is passing

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through this arc the slide will remain stationary. This motion is used on certain types of sewing machines and printing presses.

152. The type of cam used on the needle bars of some sewing machines. A pin on a rotating disk engages a slot in a cam yoke on the needle bar. This slot is formed with a curve at one place, which holds the bar stationary, while the pin is passing through it. This causes the needle to stop while the shuttle passes.

153. This cam motion differs from that of Figure 152, in that it causes the sliding bar to stop midway of its upward stroke and midway of its downward stroke. The cam slot comprises two parallel sections connected by two curved sections. While the pin on the rotating disk passes through the curved sections the bar is held stationary.

154. The cam here shown causes the sliding bar to stop at the end of each stroke. The cam is triangular, with curved faces, and rotates between the two parallel working faces of a cam frame on the sliding bar. While the outer face of the cam engages the frame the bar is held stationary. This is a form of cam motion used in place of an eccentric for operating the valve of a certain French engine.

155. A peculiar variable intermittent motion of the sliding rod is given by the planetary action of a cam mounted on a rotating disk. The cam shaft passes through the disk and carries a pinion which meshes with a stationary internal gear wheel.

156. A rectangular motion is imparted to the cam frame by two triangular curved cams mounted on a rotating shaft. The frame is mounted to slide laterally in bearings, which in turn are permitted to slide vertically in grooves on two stationary supports. The frame is made up of two horizontal rails on which one of the cams acts, and two vertical rails on which the other cam acts The illustration shows the frame about to be moved downward by the forward cam acting on the lower rail while the rear cam prevents any lateral movement. On the next quarter rotation of the cam shafts a lateral movement will ensue, due to the rear cam acting on the right-hand vertical rail. At the same time the forward cam will hold the frame against vertical movement. During the third quarter of the rotation the frame will be lifted, and during the last quarter it will be moved back laterally to the position illustrated. If the cams are both of the same size, the motion of the frame will trace a perfect square.

157. Means for converting rotary motion into vibrating motion. A forked lever engages opposite edges of a disk cam, and is thereby caused to vibrate. This cam, as that in Figure 145, is so cut that its opposite edges are everywhere equidistant when measured through the center. For this reason it is obvious that such a cam must always be cut with an odd number of projections.

158. A recently patented mechanism for imparting power to the dasher shaft of a churn. A rocking movement is imparted to the shaft from a rotating cam. At the upper end of the shaft is a forked piece or follower mounted to turn in a socket at right angles to the axis of the shaft. The follower engages a spline on the cam and is thereby guided first to one side, and then to the other of the cam, rocking the shaft on its axis.

159. Trammel Gear.—A reciprocating movement of the rod is produced by the rotation of a shaft, and *vice versa*. Pivoted to the rod are two blocks which slide respectively in two slots in the face of the disk which cross each other at right angles. This movement was patented seventy years ago, but is constantly being reinvented as a substitute for the crank.

160. Mechanism for converting rotary motion into reciprocating motion. This is a common form of eccentric used on steam engines, etc., for communicating a reciprocating motion to the valves from the crank shaft. The rod is provided with a circular strap which is bolted over a disk or ring eccentrically mounted on the crank shaft.

161. This form of eccentric is similar to that shown in Figure 160, but an oval cam frame or yoke is used in place of a circular strap, so as to produce a rectilinear reciprocating movement of the rod. This form of eccentric acts directly on the valve rod which travels between fixed guides.

162. Spiral Cam for converting rotary motion into reciprocating motion. The cam is formed with a flange or spline, disposed spirally on the curved face of the wheel. The spline engages a notch in a rod and gives the latter a reciprocating movement when the cam is rotated.

163. Elliptical Crank.—Two cranks are connected with a single pitman, the outer one, through a connecting link. The circular movement of the inner crank causes the outer end of the pitman to move in an elliptical orbit, thereby increasing its leverage at certain points.

164. A device for gripping a bar or cable. The bar travels between a fixed guide and the cam-shaped head of a lever. When the lever is thrown up, friction of the bar on the cam tends to rotate the latter until it becomes wedged between the cam and the fixed guide.

165. Lever Toggle-joint.—A device commonly used on letter-presses. One of the two connected arms is pivoted to the platen of the press and the other is hinged to a fixed standard. By lifting the lever on one of the toggle arms the arms will be brought into vertical alignment with each other, producing a powerful pressure on the platen.

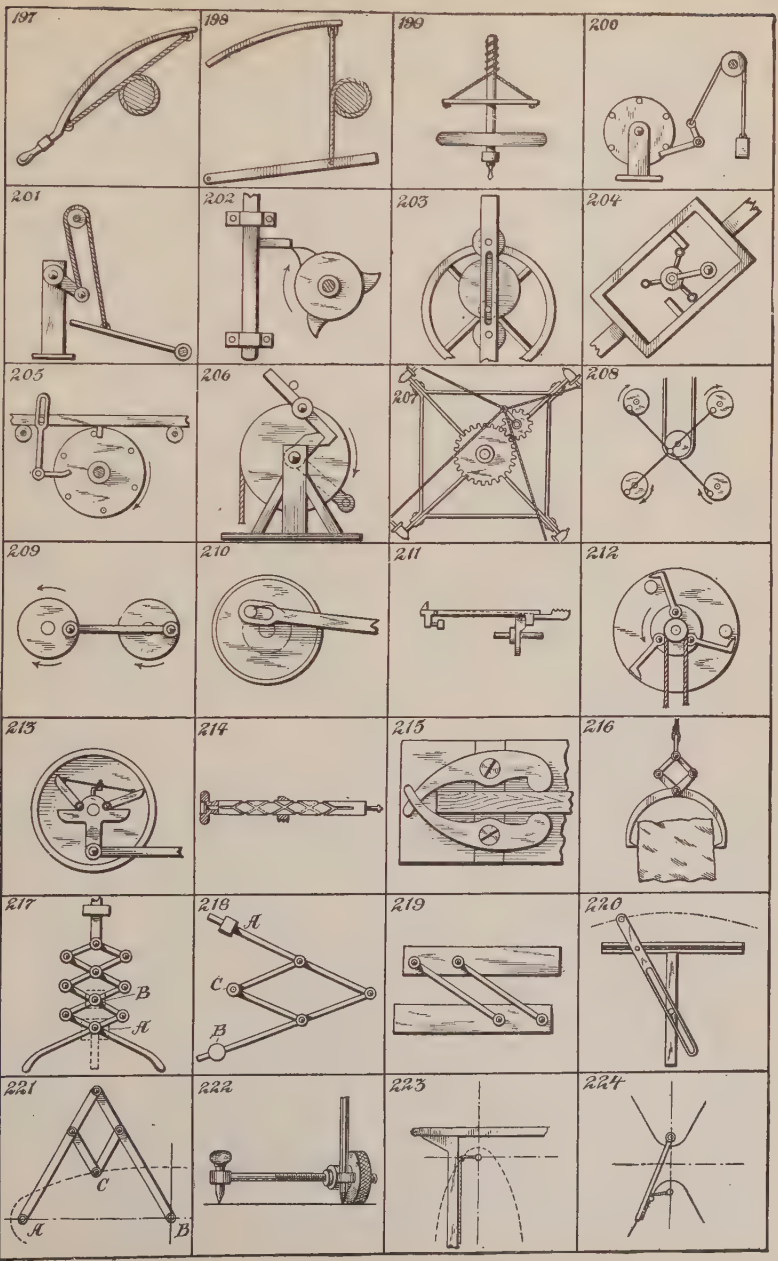
166. Screw Toggle Press.—Two toggle arms are hinged to the letter-press and at their outer ends are hinged to nuts on the feed screw. The screw is cut with right- and left-hand threads, so that when turned in operative direction it will draw the arms toward each other and press the platen downward.

167. Bell Crank Toe Levers.—Two bell crank levers are provided with projecting toes which bear against each other. When one of these levers is swung on a center it causes the other to swing also, but at a variable speed, due to the varying leverage. This mechanism is used for a type of valve gear.

168. Wiper Cam.—A type of cam used on certain stamp mills to lift the hammer. The cam bears against a flanged collar on the hammer spindle, which permits the latter to rotate.

## MISCELLANEOUS MOVEMENTS.

169. Device for transmitting reciprocating motion from one pair of rods to another pair lying at right angles thereto. The rods are all connected by links so that when two opposed rods are moved inward or toward each

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other, the other two rods will be moved outward, and *vice versa*. Also if two adjacent rods be moved the one outward, and the other inward,the opposite rods will be moved one outward and the other inward respectively.

170. Means for converting rotary into reciprocating motion. A bent shaft carries at its outer end an arm which is loosely mounted thereon. The lower end of this arm engages a slot in a bar which is mounted to slide in suitable guides. As the bent shaft rotates, the arm which is prevented from rotating with the shaft is given a rocking movement in the direction of its axis, and thus imparts a reciprocating movement to the bar.

171. Movement used on hand stamps. The plate which carries the type normally lies face upward against an ink pad, and is formed with a flange at each end in which cam slots are cut. The type plate is pivoted in a yoke piece to which the handle is secured, the pivot pins passing through slots in the uprights of the frame. When the handle is depressed, the type plate is carried downward and at the same time rotated by engagement with two pins which operate in the cam slots so that the type will face downward when brought into contact with the paper. The parts are returned to normal position by a spring on release of the handle.

172. A peculiar device for alternately rocking a pair of levers by means of a reciprocating rod. The rod carries a bell crank lever, *A*. This lever is normally held in the position illustrated by two pins against which it is pressed by the spring-pressed rod. Two bell crank levers, *B* and *C*, connected by a bar, are hinged adjacent to the rod. With the parts in the position illustrated, when the rod is drawn forward, one arm of the bell crank, *A*, will engage a pin at the end of lever, *B*, and will be thereby turned until it engages a stop piece, *D*, on the rod, after which it will operate to swing bell crank, *B*, on its axis. Owing to the connection between the levers *B* and *C*, the latter will also be swung but in the opposite direction. On return of the rod the bell crank lever, *A*, is brought to normal position by the two position pins, and when next the rod is drawn forward, the other arm of lever *A* will engage a pin on lever *C*, returning both levers *B* and *C* to their original positions.

173. Mechanism for transmitting rotary motion at increased speed from one shaft to another in alignment therewith. The lower or driving shaft carries a crown wheel at its upper end which is engaged by a second crown wheel having universal joint connection with a stationary central post. The latter is supported from the frame by cross arms, which are adapted to engage slots cut in the second crown wheel, and thus prevent the wheel from rotating. The upwardly projecting frame of the second crown wheel is connected to a wheel on the upper shaft, but eccentric thereto, by means of a ball-and-socket joint. The driven crown wheel is thus tilted so as to engage the teeth of the driving wheel. As the latter rotates the driven wheel is given a rocking or wobbling movement, which rotates the upper shaft. A slight movement of the lower shaft thus produces a complete rotation of the upper shaft.

174. A device for converting reciprocating into rotary motion and *vice versa*. Two intermeshing gear wheels are provided with spring pawls oppositely disposed on the gears, and adapted alternately to snap into engagement with a lug on a reciprocating rod and thereby impart rotary motion to the gears.

175. A device for spacing apart a number of bars. The bars are arranged to slide with a certain amount of friction between guide pieces. Normally they are crowded together in a group by a pair of coil springs. A pair of rotating spur wheels whose teeth engage the pointed ends of the bars are mounted on either side to slide vertically in suitable guideways. The vertical movement of the gears carries the bars downward against the springs and the slow rotary movement of the gears successively releases the bars at regular intervals. The bars remain where released, being held by frictional engagement with the guide pieces.

176. An early form of flexible shaft coupling. One of the shafts is pointed and fits into a socket in the other shaft. Each shaft carries a collar and these are connected by a flat spiral spring.

177. Centrifugal hammer. Two hammers are hinged on a rapidly revolving disk. As the disk revolves, these hammers are alternately swung by the added force of gravity and of centrifugal action, on to the anvil. A very powerful stroke is thus given.

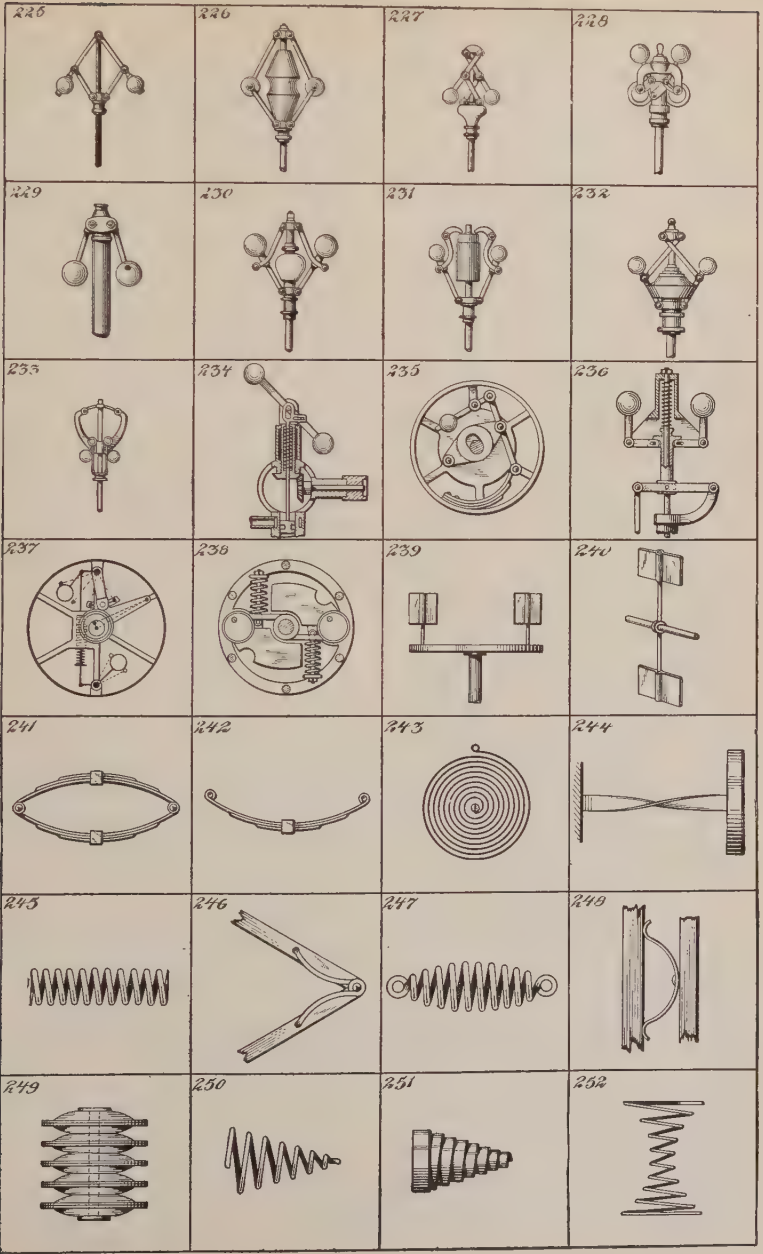
178. A device for communicating reciprocating motion of an engine to a rotating crank in such manner that the crank will have a greater throw than the stroke of the engine crosshead. The connecting rod acts on the crank shaft through a "lazy tongs" which multiplies the stroke and affords a better leverage upon the same.

179. A device for producing two rotations of the crank shaft of an engine at each complete (forward and return) stroke of the crosshead. The crosshead of the engine is connected by a rod to a pair of connected levers, one of which is pivoted on a fixed pin and the other to the working beam. Owing to the toggle action of the levers the working beam will rise and fall twice while the crosshead moves to its outer position and returns.

180. A device for converting rocking movement into rectilinear reciprocating movement, usually called "parallel" motion. Two links pivoted on the fixed pin *A* connect at their outer ends with two links pivoted on a rod at *D*. The latter links are also connected to a pair of links pivoted to a rock arm *C*. The distance between *A* and *B*, the fixed pivot of the rock arm, is equal to the distance between *B* and *C*. Owing to the fact that the double link-quadrangle swings on two pivots, it will be lengthened when swung out of the vertical position, thus giving a rectilinear motion to the rod *D*. This movement is called "Peaucellier's" parallel motion. It is used to give rectilinear movement to a pump rod or to the piston rod of an engine.

181. Another device for producing rectilinear movement of a pump rod. The rod, instead of being directly connected to the working beam of an engine, is connected thereto by cross links. This motion, however, is not a true "parallel motion," but the rod is strained by cross connection.

182 to 184. Devices for overcoming "dead" centers of cranks. In Figure 182 the pitman is connected to one end of a leaf spring, whose other end is connected to the crank disk. The

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pitman is thus permitted to play between two socket lugs projecting from the face of the disk. Just before the back center is reached, the pitman slips out of engagement with the lower socket, by reason of the tensile strain on the spring, then on the return stroke, the connection of the spring being above the line of centers, the spring yields and throws the pitman back into the lower socket, and acts upon it to rotate the disk, until the forward center is reached, when the action will be the reverse of that just described. In 183 the pitman is attached to a plate secured to the flywheel at two points by screws passing through slots cut diagonally in the plate. In starting the wheel from either of its dead centers, the pitman will cause the plate to slide on its diagonal slots and the pitman will thus carry itself out of the dead center. The plate will then be returned to normal position by a spring. The device shown in 184 is specially applicable to machines operated by treadles. Attached to the pitman is a piston acting in a cylinder pivoted to the rod on which the treadle is hinged. Within the cylinder are two coil springs which alternately act on the piston to carry the crank over the two dead centers.

185. A device for transmitting motion from one shaft to another lying at right angles thereto. The driving shaft is formed with a spiral ribbon which acts between rollers radially mounted on a wheel, carried by the driven shaft. The wheel is formed with a double series of rollers, one on each side of the spiral shaft, but the forward series has been cut away in the illustration to show detail. The action is similar to that of a worm and worm wheel, but friction is reduced by the use of the rollers.

186. An internal worm gear is here shown which offers the same advantages as the internal spur gear, namely, that of greater strength due to the fact that the area of contact between the worm and the worm wheel is increased. The worm wheel is made up of two hollow sections, clamped together, but so spaced as to form a slot in the rim through which the worm shaft passes.

187. Means for converting rotary motion into rocking motion. The power shaft carries two cams formed with corrugated peripheries. On opposite sides of the rock shaft are two rollers, one for each cam. The cams are so spaced that when one roller is being lifted, the other will fall. Thus, a rocking motion is imparted to the rock shaft. The same effect may be produced by using a single broad cam for the two rollers, but spacing one roller a little in advance of the other on the rock shaft.

188. Another form of internal worm gear. A worm wheel is mounted on a stationary bracket and engages the spiral thread formed in a ring. As the ring revolves about the gear, the latter is caused to slowly rotate. As in Figure 186, a very strong construction and powerful transmission is afforded by this arrangement

189. A sliding toggle movement is here shown for producing great pressure in a direction at right angles to that of the impelling force. The toggle members are so mounted and are of such shape that they combine the action of the inclined plane with the ordinary toggle action.

190. Means for giving parallel movement to the paddles of steamboats, etc. The power shaft carries a disk which is connected by a series of hinged links with a ring held eccentrically to the shaft, between pairs of rollers. The paddles are attached to the links and are thereby kept parallel, while the disk and ring rotate. This same arrangement can be used to communicate motion to shafts lying out of alignment with each other, one of the shafts being attached to the ring.

191. Device for transmitting motion from one shaft to another at decreased velocity. The device is here shown diagrammatically. The driving shaft carries an eccentric $A$, upon which spur gears $B$ and $C$ are fitted to turn freely. The latter are permanently secured together. Wheel $B$ meshes with internal gear $D$, on the driven shaft, and wheel $C$ meshes with the stationary internal gear $E$. In operation the eccentric carries gear $C$ about gear $E$, thereby causing it to rotate on its own center. The gear $B$ will be revolved by the eccentric in one direction and be rotated in the opposite direction by the gear $C$ to which it is attached, thus causing the gear $D$ to move at a reduced speed,

192 to 196. Ball-bearing Devices.—In 192 is shown a ball-bearing knuckle joint consisting of a flanged socket member having sockets for the reception of steel friction balls, and a second member formed with flanges which bear against the friction balls. When the device is in operation, the balls will roll back and forth in their sockets at each rotation of the knuckle joint. In 193 a common form of ball-bearing is shown. The balls are held in stationary cups and bear against cones on the rotating shaft. 194 shows an end-thrust ball bearing of common form. 195 shows a ball-bearing wheel or caster. The balls are arranged to travel over an endless path, being guided from the forward end of the wheel bearing, through a passageway in the body of the caster, to the rear of the wheel bearing surface. 196 shows the same principle applied to a worm and worm wheel. The thread of the worm does not engage the teeth of the worm wheel, but communicates motion thereto through a series of balls. The latter, when they reach the end of the worm thread, are guided back through a passageway in the worm body to the beginning of the thread.

197. Means for converting reciprocating rectilinear movement into reciprocating rotary movement. A primitive form of turning lathe. The wooden shaft or other object to be turned, is mounted to rotate freely between pivot pins. A rope coiled about the shaft has its free ends secured to a spring bow. In operation, the handle of the bow is seized in one hand, and the other hand holds the tool against the work, which is rotated first in one direction, and then in the other, by moving the bow back and forth.

198. This is another form of primitive lathe which, however, is adapted to be driven by foot power. The rope, which is wound around the shaft is secured at its upper end to a spring, usually the end of a thin board, and at its lower end to a pedal. When the latter is depressed, the shaft will rotate toward the cutting tool and on its release the spring will cause it to rotate back, ready for the next downward stroke of the pedal. This type of

lathe is still commonly used in some Eastern countries.

199. An ancient form of drill, but one which is still used by jewelers. Coiled about the spindle of the drill are two cords whose lower ends are secured to a cross piece mounted to slide up and down on the spindle. When the cross piece is pressed downward, it causes the cords to uncoil, rotating the spindle. When the cross piece reaches the bottom of its stroke the pressure on it is relieved, and due to the momentum of a heavy flywheel on the spindle, the latter continues to rotate, recoiling the cords and lifting up the cross piece. On the next downward stroke of the cross piece, the spindle will rotate in the opposite direction.

200. Trip hammer. A rotating disk is formed with a series of pins adapted consecutively to depress one arm of a bell crank to the opposite arm of which a hammer weight is connected by a cord. When the bell crank clears a pin on the disk, the weight drops, delivering the blow, and is then lifted again by the next pin acting on the bell crank.

201. Means for converting reciprocating motion into rotary motion. A rope attached at one end to a foot pedal passes over an intermediate pulley, and is attached at the other end to the weighted crank arm of a shaft. The arrangement is such that on the downward or power stroke of the pedal, the weighted arm will be lifted to the vertical position, when it will be assisted by gravity and its own momentum to continue its rotation and lift the pedal for the next downward stroke.

202 to 205. Means for converting rotary motion into rectilinear motion. In 202, secured to a rotating shaft is a cam formed with projecting horns, which are adapted to successively engage a lug on a sliding rod. The rod is thereby given a trip-hammer movement, dropping by gravity as the lug clears the horns. In 203, a disk mounted eccentrically on a rotating shaft is engaged on opposite sides by a pair of rollers, pivoted to a rod. As the shaft rotates, the rod will be moved up and down, following the eccentric movement of the disk. This movement is used on windmills to transmit motion from the rotating windmill shaft to the pump rod. In 204 a shaft is provided with radial arms bearing rollers at their outer ends. These are adapted to operate within a frame mounted to slide, and formed with two lugs diagonally disposed on opposite sides of the frame. When the shaft is rotated, by means of the crank arm shown, the frame will be moved first to one side by one of the rollers engaging one of the lugs, and then in the opposite direction by another of the rollers moving into engagement with the other lug. In 205, a sliding carriage is formed with a lug adapted to be engaged successively by a series of pins on a revolving disk. The carriage will be moved forward by one of the pins until the latter clears the lug, when the carriage will be moved back again by another pin engaging an arm of a bell crank whose other arm engages the carriage.

206. Automatic release for a winding drum. A winding drum is mounted to turn freely on a shaft. A hook is pivoted on the face of the drum, and when it is desired to rotate the drum the hook is brought into engagement with a tappet on the shaft. When, however, the weight has been raised to a predetermined position by the winding drum, a pin strikes the hook, releasing it from engagement with the tappet and permitting the weight to drop.

207. An amusement device called the "Flying Horse" used in parks and fairs. A frame mounted to rotate on a vertical spindle, is provided with a simple gear wheel, which meshes with a driving pinion. By alternately pulling the cords, radiating from a crank on the shaft which carries the pinion, the persons occupying the seats or horses at the corners of the frame, are enabled to keep the apparatus in motion.

208. This figure shows a single pulley driving four other pulleys by means of a cross-shaped connecting rod. This form of drive is occasionally used for rotating wheels or cylinders which lie so close to each other that no gearing or other mechanism for transmitting motion can be used.

209. This figure illustrates the rather curious fact that if two wheels are coupled together by a connecting rod, whose crank pins are respectively equally distant from the centers of the wheels, then while one wheel is constantly rotated in one direction the other may be rotated in the same direction, or in the opposite direction, as desired.

210. A stop motion used in brick machines for drawing the mold back and forth, and bringing it to rest at each stroke to permit of depositing the clay and removing the brick. A rotating wheel carries a crank pin which engages a slot in a connecting rod. At the end of its forward stroke, and at the end of its return stroke the connecting rod will remain stationary, while the crank pin moves from one end of the slot to the other.

211. A device used in sewing machines for feeding the goods under the needle. The feed bar is formed with teeth at one end and the opposite end is pivoted between the arms of a forked lever. The feed bar is lifted by a peripheral projection on a cam, and at the same time the forked lever is moved forward by a projection on the side face of the cam, which bears against a lug carried on the lever. A spring at the opposite end of the lever normally holds the lug in contact with the face of the cam.

212. Elevator safety device. Secured to the side of the elevator shaft is a plate formed with one or more studs. To the winding drum of the elevator a number of hooks are pivoted. When the drum rotates the hooks are thrown out by centrifugal action, and if dangerous speed is acquired, they swing out far enough to catch hold of one or more of the studs, bringing the drum to a stop. The shock of the sudden stoppage is usually taken up by a coil spring on the drum.

213. A device for converting oscillating motion of a lever into intermittent rotary motion. A crank arm which is provided with two pawls hinged to its upper end, is oscillated within the rim of a wheel. The pawls are connected by a cord to a small crank, which may be turned so as to bring one pawl into frictional engagement with the rim of the wheel, and thereby cause the wheel to rotate intermittently. When it is desired to reverse the direction of rotation, the crank is turned, raising the first pawl and bringing the other one into engagement with the wheel.

214. Means for converting rectilinear motion into rotary motion. This is used on certain forms of drill stocks. The drill stock is cut with two spiral grooves, one of which

is left-handed and the other right-handed. A ring on the drill stock is provided with a follower which follows one of the grooves on the forward stroke, and the other groove on the return stroke, thus causing the drill to turn always in the same direction.

215. An automatic bench clamp, used by carpenters for holding the work while planing, etc. Pivoted to the work bench are two cam levers, formed with curved ends, which are moved apart by the work as it is pressed in between them, thus causing the clamping ends of the levers to tightly grip the work.

216. Gripping tongs for lifting stones and the like. The upper arms are connected to a shackle by a pair of links so that when a pull is exerted on the shackle, the arms are drawn together, pressing the points into the stone; the heavier the stone lifted the more tightly will the arms be drawn together, thus increasing the grip on the stone.

217. A series of cross connected levers used for multiplying or reducing motion. In the illustration, the lowest pair of levers is pivoted to a fixed pin *A*, and the arrangement is such that if one pair of the crossed levers be folded together, the entire series will fold, giving the rod attached to the upper pair of levers a greatly multiplied longitudinal movement, and conversely if the rod be moved, a greatly reduced motion will be given to the lower pair of links. The extent to which the motion is multiplied or reduced is directly proportional to the number of pairs of levers in the series. This device is called a "lazy tongs." The figure also shows a means for multiplying motion imparted from one rectilinear reciprocating rod to another. If the fixed pivot of the lazy tongs be at *B*, on giving reciprocating motion to the lower rod, the reciprocating motion will be imparted to the upper rod, but the travel of the upper rod will be twice that of the lower rod.

## DRAFTING DEVICES.

218. A pantograph, or an instrument for reproducing a drawing on a larger or smaller scale. It comprises two levers hinged together and connected by a pair of hinged links. One of the levers carries a slide, *A*, in which a pencil is secured. The other lever carries a pivot pin, and the tracing point is located at *C*. In use the device is made to turn on the fixed point at *B*, then on moving the tracing point *C* over a drawing, the same will be reproduced by the pencil at *A*. By varying the positions of the pencil and the pivot pin on their respective levers, the reproduction may be made larger or smaller than the original as desired.

219. This figure shows the "parallel ruler," a device used for drawing parallel lines. Two parallel rulers are connected by a pair of parallel links of equal length. The rulers will then always lie parallel to each other, whether swung apart or moved together.

220. A device for drawing a conchoid curve. A conchoid curve may be described as a curve of such form that when measured along lines drawn from a fixed point called the pole, it will, at all points, be equidistant from a straight line, called the asymptote. The device shown comprises a T-square with grooved head-piece adapted to receive a slide pivoted to a bar. A slot in the lower end of this bar engages a pin on the blade of the T-square and the opposite end of the bar carries the scribing pencil. The pin represents the pole and the grooved head of the T-square represents the asymptote. The curve traced by the pencil when measured along the bar lies everywhere equidistant from the asymptote.

221. An ellipsograph or a device for drawing ellipses. This is similar to the pantograph shown in Figure 218. The fixed pivot, however, is at *B*, the tracing point at *A*, and the pencil at *C*. When *A* is moved in a straight line toward or away from *B*, the pencil *C* will trace an elliptical curve.

222. A device for drawing a helical curve. A rod provided with a pivot point is threaded to receive a nut with a milled flange. As the rod is moved about ts center, the nut is rotated by a frictional contact of the flange with the drawing paper, and is thus slowly fed toward or away from the center. A pencil carried by a sleeve on this nut will then trace a helical curve.

223. A device for describing parabolas. A pin is placed at the focus of the desired parabola and a straight-edge is placed on the line of the directrix. A slack cord is secured at one end to the pin, and at the other to the blade of a square whose stock bears against the straight edge. The slack of the cord is taken up by the pencil, which bears against the blade of the square. Sufficient slack is provided to make the distance of the pencil from the focus equal to its distance from the straight-edge or directrix. The curve then described by the pencil while keeping the cord taut against the square, as the square is moved along the straight-edge, will be a parabola.

224. A device for describing hyperbolas. The two pins shown represent the foci of two opposite hyperbolas. A ruler turns on one of these pins as a center, and its opposite end is connected with the other pin by a slack cord. The slack of the cord is taken up by the pencil which bears against the ruler. The curve described will then fulfil the conditions of a hyperbolic curve, which requires that the distance from any point in the curve to its focus, minus the distance from that point to any other fixed point or focus, should always be a constant quantity.

## GOVERNORS.

A governor of a steam engine is a device for automatically operating the throttle, or for shortening the stroke of the slide valve when the engine attains a dangerous speed.

225. Watt's Governor.—When a dangerous speed is acquired, the centrifugal force acting upon a pair of balls tends to lift a sleeve which, through a bell crank, operates the throttle.

226. Porter's Governor.—The operation is very similar to that of Watt, but the balls are required to lift a weight which may be adjusted as desired.

227. Kley's Cross Arm Governor.—The degree of sensitiveness is governed by the length of the cross arms, and also by an adjustable weight, which is lifted by the balls.

228. Buss' Governor.—Two pairs of balls are used, one pair acting to counterbalance the other.

229. Tangye's Governor.—The balls when thrown out by centrifugal action depress a rod in the hollow central shaft and this rod acts directly on the block in the link thus shortening the stroke of the slide valve

230 and 231. PROELL'S GOVERNOR.—In 230 the balls, aside from lifting a weight, act to compress a spiral spring. In 231 the outward movement of the balls is controlled by an air dashpot.

232. COSINE GOVERNOR.—A cross arm governor which acts to raise a weight.

233. PARABOLIC GOVERNOR.—The balls move on parabolic guide arms, which modify the effect of the centrifugal force, and produce equal valve movement, which is exactly proportional to the speed of the engine.

234. OSCILLATING LEVER GOVERNOR.—The balls are secured to the ends of a lever, which assumes a more horizontal position as the speed of the engine increases. A spring normally holds the arm in the tilted position illustrated.

235. SWEET'S FLYWHEEL GOVERNOR.—The centrifugal action of the ball moves the eccentric toward the center, thus reducing the stroke of the slide valve. A leaf spring resists the centrifugal action of the ball.

236. HARTNELL'S EXPANSION GOVERNOR.—The balls are thrown out by centrifugal force against the action of a spring raising the block in the link and thus varying the stroke of the valve.

237. HARTNELL'S CRANK SHAFT GOVERNOR.—The weights operate against the spring to move a toothed sector, which moves the eccentric toward the center of the crank shaft, thus varying the stroke of the slide valve.

238. TURNER'S CRANK SHAFT GOVERNOR.—The weights have bearings in the side plates of the governor. They also carry pins by which they are connected to the eccentric. When the weights are thrown out by centrifugal action, they move the eccentric toward the center of the crank shaft.

239 and 240. VANE GOVERNORS.—The shaft is prevented from rotating too rapidly by the atmospheric resistance acting on a pair of vanes. This resistance may be varied by adjusting the vanes to different angles. In some types of vane governors the inclined vanes serve to lift a sleeve, cutting off the supply of power.

## SPRINGS.

241 and 242. LAMINATED OR CARRIAGE SPRINGS, used on carriages to take up the jolts of the wheels in passing over uneven roads. 241 shows the elliptical form, and 242 the semi-elliptical form. They are built up of flat spring metal strips.

243. WATCH OR CLOCK SPRING, used to drive a watch or clock train. The spring is formed of a flat spring metal strip, wound into a flat coil.

244. RIBBON SPRING.—A strip of flat spring metal mounted to exert a torsional pressure.

245. SPIRAL SPRING.—A length of round spring wire wound into spiral form. This spring could be used either as a tension or as a compression spring, though usually it has the form shown in Figure 247 when used as a tension spring. A spiral spring should never be extended or compressed more than one-third of its length.

246. SEAR SPRING.—This spring gets its name from its use in gun locks for causing the sear to catch in the notch of the tumbler. However, the spring is here shown as holding apart the arms of a compass.

247. TENSION SPIRAL SPRING.—A spiral spring which tapers toward the ends so that the pull will come centrally on the spring, thus giving an even tension and avoiding side strains.

248. FLAT OR LEAF SPRING.—A strip of flat spring metal used chiefly as a compression spring. A spring of this type is apt to lose its resiliency after continued use.

249. DISK SPRING.—A compression spring made up of a series of dished disks or plates.

250. HELICAL SPRING.—This spring differs from the spiral spring, Figure 245, in that it is formed by being wrapped around a cone, whereas a spiral spring is formed by being wrapped around a cylinder. The helical spring may safely be compressed until it lies flat like a clock spring.

251. VOLUTE SPRING.—A compression spring formed by coiling a flat spring ribbon into a helix.

252. FURNITURE SPRING.—A compression spring comprising a double helical spring used in furniture to support the cushioned backs or seats of chairs. This spring is also used in bed springs.

## TRANSMISSION OF POWER BY BELTING.

THE TENACITY OF GOOD NEW BELT LEATHER varies from 3,000 lb. to 5,000 lb. per square inch of sectional area.

THE COEFFICIENT OF FRICTION between ordinary belting and cast-iron pulleys is about .423.

THE THICKNESS OF BELTS varies from three-sixteenths to five-sixteenths of an inch, or an average of one-fourth of an inch.

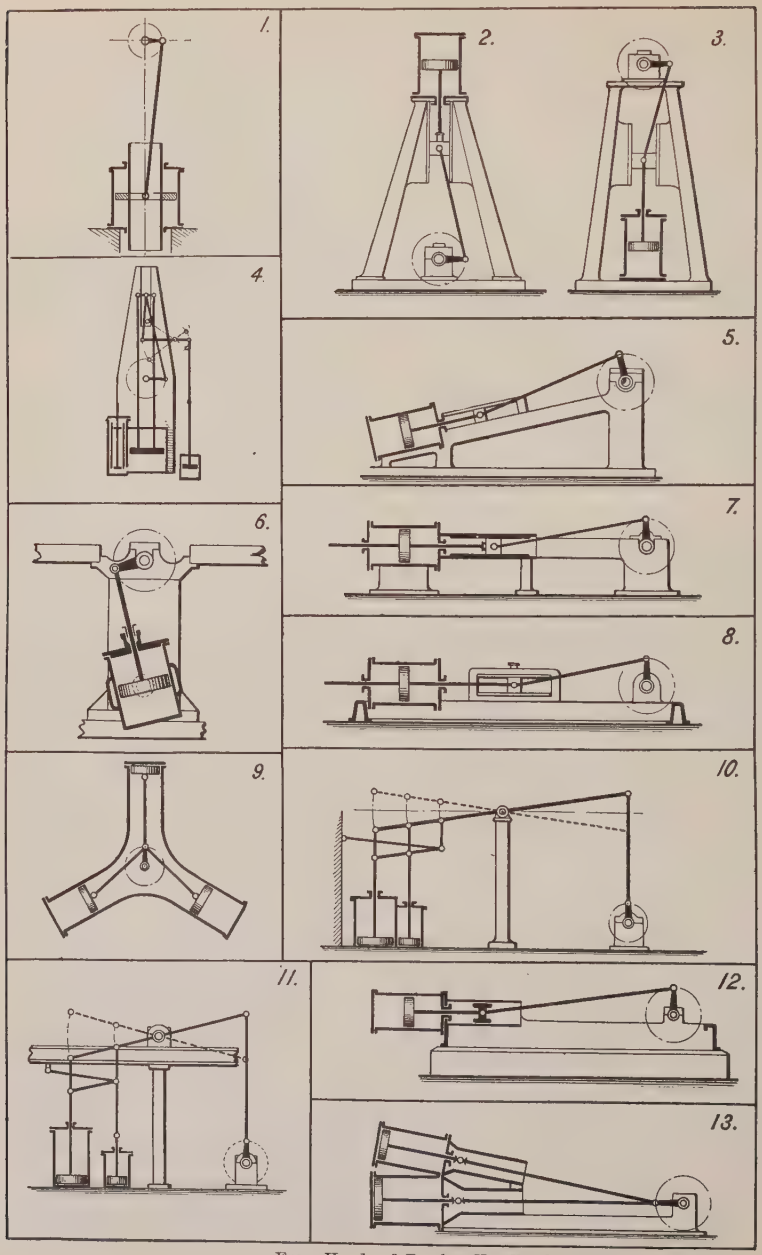
TENACITY OF RIVETING AND LACING.—The ultimate tenacity of good single leather belting may be taken at about 1,000 lb. per inch in width; the corresponding strength of a riveted joint being about 400 lb., a butt laced joint about 250 lb., and an ordinary overlap laced joint 470 lb. It is not customary, however, to allow an effective strain of more than one-fourth these amounts.

WORKING STRESS OF BELTS.—The following are the effective working stresses allowed for the different kinds and thicknesses of belts referred to in the table of powers.

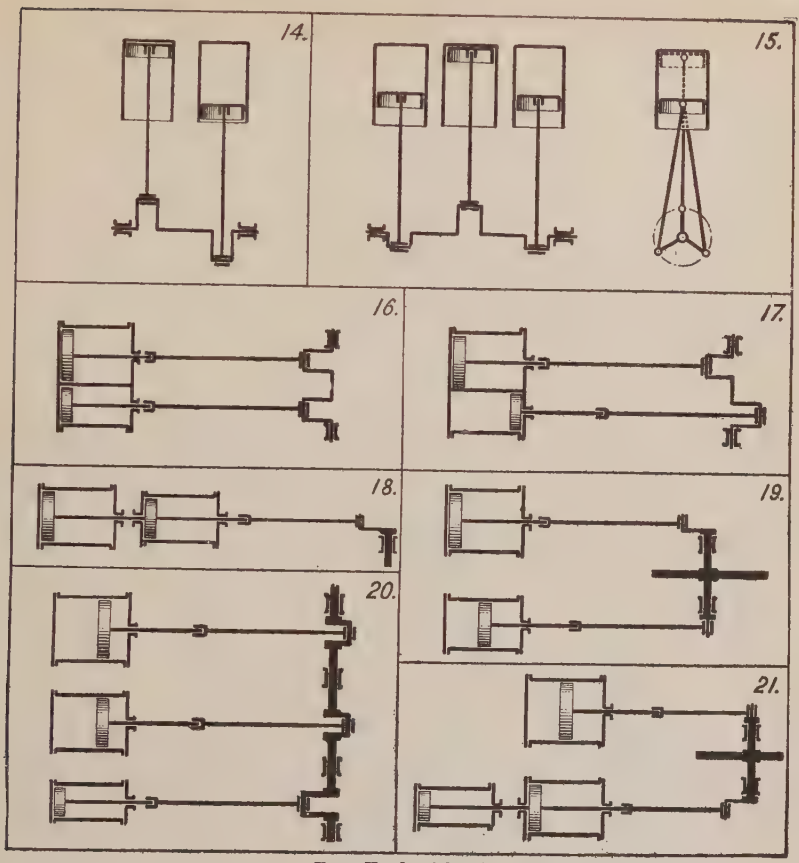
| | |
|---|---|
| Ordinary single belts, | 50 lb. |
| Light double belts, | 70 lb. |
| Heavy double belts, | 90 lb. |
| Link belts, $\frac{3}{8}$ in. thick, | 42 lb. |
| " " $\frac{1}{2}$ in. " | 48 lb. |
| " " $\frac{5}{8}$ in. " | 57 lb. |
| " " $\frac{3}{4}$ in. " | 66 lb. |
| " " $\frac{7}{8}$ in. " | 78 lb. |
| " " 1 in. " | 90 lb. |

SPEED OF BELTING.—On ordinary shop line shafts the velocity of the belts varies from 1,000 ft. to 1,500 ft. per minute. Lathe belts vary from 1,500 ft. to 3,000 ft. per minute.

STRESS ON SHAFTING.—The cross stress on shafting arising from the sum of the tension on the two sides of the belt may be taken at 90 lb. per inch in width.—Practical Electrical Engineers' Pocket Book and Diary.




—From Haeder & Powles' Handbook on the Steam Engine.




—From Haeder & Powles' Handbook on the Steam Engine.

## TYPES OF ENGINES.

1. Trunk Engine.
2 and 3. Vertical Engines.
4. Steeple Engine.
5. Inclined Frame Engine.
6. Oscillating Engines.
7. Corliss Frame or Girder Engine.
8. Horizontal Engine.
9. Radial Engine.
10. Beam Engine.
11. Beam Engine
12. Self Contained Horizontal Engine.
13. Inclined Cylinder Engine.
14. Double Cylinder with Cranks opposite or at 180°.
15. Three Cylinder Engine with Cranks at 120°.
16. Compound Woolf Engine with Cranks together.
17. Compound Woolf Engine with Cranks opposite or at 180°.
18. Compound Tandem Engine with Receiver.
19. Compound Engine with Cylinders side by side and Cranks at 90°.
20. Triple Expansion Engine, Cylinders side by side and Cranks at 120°.
21. Triple Expansion Engine, semi-tandem: Two Cranks at 90°.

# PART III.

# CHAPTER I.

## CHEMISTRY.

### TABLE OF ELEMENTS.*

| Elements. | Discoverer. | Year. |
|---|---|---|
| Antimony | Valentine | 1450 |
| Bismuth | Valentine | 1450 |
| Zinc | Paracelsus | 1520 |
| Phosphorus | Brandt | 1669 |
| Arsenic | Schröder | 1694 |
| Cobalt | Brandt | 1733 |
| Nickel | Crondstadt | 1751 |
| Hydrogen | Cavendish | 1766 |
| Nitrogen | Rutherford | 1772 |
| Manganese | Gahn | 1774 |
| Oxygen | Priestley | 1774 |
| Tungsten | d'Elihujar | 1781 |
| Molybdenum | Hjelm | 1782 |
| Tellurium | Reichenstein | 1782 |
| Uranium | Klaproth | 1789 |
| Titanium | Klaproth | 1795 |
| Chromium | Vauquelin | 1797 |
| Tellurium | Klaporth | 1798 |
| Columbium | Hatchett | 1801 |
| Tantalum | Hatchett & Ekeburg | 1802 |
| Palladium | Wollaston | 1803 |
| Osmium | Tennant | 1803 |
| Cerium | Berzelius, Hisinger & Klaproth | 1803 |
| Iridium | Tennant | 1804 |
| Rhodium | Wollaston | 1804 |
| Potassium | Davy | 1807 |
| Sodium | Davy | 1807 |
| Barium | Davy and Berzelius & Pontin | 1808 |
| Strontium | Davy | 1808 |
| Magnesium | Davy | 1808 |
| Calcium | Davy and Berzelius & Pontin | 1808 |
| Boron | Davy and Gay-Lussac & Th(nard | 1808 |
| Chlorine | Davy | 1810 |
| Fluorine | Ampère | 1810 |
| Iodine | Courtois | 1811 |
| Selenium | Berzelius | 1817 |
| Cadmium | Hermann & Stromeyer | 1817 |
| Lithium | Arfvedson | 1817 |
| Silicon | Berzelius | 1823 |
| Zirconium | Berzelius | 1824 |
| Bromine | Balard | 1826 |
| Thorium | Berzelius | 1828 |
| Yttrium | Wöhler | 1828 |
| Glucinum | Wöhler | 1828 |
| Aluminum | Wöhler | 1828 |
| Vanadium | Sefstroem | 1830 |
| Lanthanum | Mosander | 1841 |
| Didymium | Mosander | 1841 |
| Erbium | Mosander | 1843 |
| Terbium | Mosander | 1843 |
| Niobium | (same as Columbium, q. v.) | 1844 |
| Ruthenium | Claus | 1844 |
| Rubidium | Bunsen | 1860 |
| Cæsium | Bunsen & Kirchhoff | 1860 |
| Thallium | Crookes and Lamy | 1862 |
| Indium | Reich & Richter | 1863 |
| Gallium | Boisbaudran | 1875 |
| Ytterbium | Marignac | 1878 |
| Samarium | Boisbaudran | 1879 |
| Scandium | Nilson | 1879 |
| Thulium | Cleve | 1879 |
| Neodymium | Welsbach | 1885 |
| Praseodymium | Welsbach | 1885 |
| Gadolinium | Marignac | 1886 |
| Germanium | Winkler | 1886 |
| Argon | Rayleigh & Ramsay | 1894 |
| Krypton | Ramsay & Travers | 1897 |
| Neon | Ramsay & Travers | 1898 |
| Coronium | Nasini | 1898 |
| Xenon | Ramsay | 1898 |
| Victorium | Crookes | 1898 |
| Etherion (?) | Brush | 1898 |
| Polonium | Curié (Mrs.) | 1898 |
| Radium | Curiés (Mrs. & Mr.) and Bémont | 1898 |
| Actinium (Must not be confounded with Phipson's actinium.) | Debierne | 1899 |
| Asterium | hydrogen. Lockyer | 1899 |
| (New) unknown. | | |
| Thorium $\alpha$ | Brauner | 1900 |
| Thorium $\beta$ | Brauner | 1900 |
| Krypton II | Ladenberg & Krugel | 1900 |
| Austrium II. (?) | Pribram | 1900 |
| Carolinium | Baskerville | 1900 |
| Radio-active lead (?) | Hoffmann & Strauss | 1900 |
| "$\Sigma$" Europium | Demarçay | 1901 |
| Euxenium earth (?). I. & II. | Hoffmann & Prandtl | 1901 |
| Amarillium (?) | Courtis | 1902 |
| Tellurium X | Pellini | 1903 |
| Berzelium | Baskerville | 1903 |

Revised by Professor Charles Baskerville, Ph.D., of the University of North Carolina.

* Gold, silver, tin, copper, iron, lead, mercury, and carbon have been known from the earliest times.

## INTERNATIONAL ATOMIC WEIGHTS.

| Elements. | Symbol. | O=16. | H=1. | Elements. | Symbol. | O=16. | H=1. |
|---|---|---|---|---|---|---|---|
| Aluminum | Al | 27.1 | 26.9 | Neodymium | Nd | 143.6 | 142.5 |
| Antimony | Sb | 120.2 | 119.3 | Neon | Ne | 20 | 19.9 |
| Argon | A | 39.9 | 39.6 | Nickel | Ni | 58.7 | 58.3 |
| Arsenic | As | 75.0 | 74.4 | Nitrogen | N | 14.04 | 13.93 |
| Barium | Ba | 137.4 | 136.4 | Osmium | Os | 191 | 189.6 |
| Bismuth | Bi | 208.5 | 206.9 | Oxygen | O | 16.00 | 15.88 |
| Boron | B | 11 | 10.9 | Palladium | Pd | 106.5 | 105.7 |
| Bromine | Br | 79.96 | 79.36 | Phosphorus | P | 31.0 | 30.77 |
| Cadmium | Cd | 112.4 | 111.6 | Platinum | Pt | 194.8 | 193.3 |
| Caesium | Cs | 132.9 | 131.9 | Potassium | K | 39.15 | 38.86 |
| Calcium | Ca | 40.1 | 39.8 | Praseodymium | Pr | 140.5 | 139.4 |
| Carbon | C | 12.00 | 11.91 | Radium | Ra | 225 | 223.3 |
| Cerium | Ce | 140.25 | 139.2 | Rhodium | Rh | 103.0 | 102.2 |
| Chlorine | Cl | 35.45 | 35.18 | Rubidium | Rb | 85.4 | 84.8 |
| Chromium | Cr | 52.1 | 51.7 | Ruthenium | Ru | 101.7 | 100.9 |
| Cobalt | Co | 59.0 | 58.56 | Samarium | Sm | 150 | 148.9 |
| Columbium | Cb | 94 | 93.3 | Scandium | Sc | 44.1 | 43.8 |
| Copper | Cu | 63.6 | 63.1 | Selenium | Se | 79.2 | 78.6 |
| Erbium | Er | 166 | 164.8 | Silicon | Si | 28.4 | 28.2 |
| Fluorine | F | 19 | 18.9 | Silver | Ag | 107.93 | 107.12 |
| Gadolinium | Gd | 156 | 155 | Sodium | Na | 23.05 | 22.88 |
| Gallium | Ga | 70 | 69.5 | Strontium | Sr | 87.6 | 86.94 |
| Germanium | Ge | 72.5 | 71.9 | Sulphur | S | 32.06 | 31.83 |
| Glucinum | Gl | 9.1 | 9.03 | Tantalum | Ta | 183 | 181.6 |
| Gold | Au | 197.2 | 195.7 | Tellurium | Te | 127.6 | 126.6 |
| Helium | He | 4 | 4 | Terbium | Tb | 160 | 158.8 |
| Hydrogen | H | 1.008 | 1.000 | Thallium | Tl | 204.1 | 202.6 |
| Indium | In | 114 | 113.1 | Thorium | Th | 232.5 | 230.8 |
| Iodine | I | 126.85 | 125.90 | Thulium | Tm | 171 | 169.7 |
| Iridium | Ir | 193.0 | 191.5 | Tin | Sn | 119.0 | 118.1 |
| Iron | Fe | 55.9 | 55.5 | Titanium | Ti | 48.1 | 47.7 |
| Krypton | Kr | 81.8 | 81.2 | Tungsten | W | 184 | 182.6 |
| Lanthanum | La | 138.9 | 137.9 | Uranium | U | 238.5 | 236.7 |
| Lead | Pb | 206.9 | 205.35 | Vanadium | V | 51.2 | 50.8 |
| Lithium | Li | 7.03 | 6.98 | Xenon | Xe | 128 | 127 |
| Magnesium | Mg | 24.36 | 24.18 | Ytterbium | Yb | 173.0 | 171.7 |
| Manganese | Mn | 55.0 | 54.6 | Yttrium | Yt | 89.0 | 88.3 |
| Mercury | Hg | 200.0 | 198.5 | Zinc | Zn | 65.4 | 64.9 |
| Molybdenum | Mo | 96.0 | 95.3 | Zirconium | Zr | 90.6 | 89.9 |

## REPORT OF THE INTERNATIONAL COMMITTEE ON ATOMIC WEIGHTS.

The International Committee on Atomic Weights has the honor to offer the following report:

In the table of atomic weights for 1904 only two changes from 1903 are recommended. The atomic weight of caesium has been slightly modified to accord with the recent determinations by Richards and Archibald, and that of cerium in conformity with the measurements by Brauner. The value for lanthanum is still in controversy, and any change here would therefore be premature. The same consideration may also be urged with regard to iodine. Ladenburg has shown that the accepted number for iodine is probably too low, but other investigations upon the subject are known to be in progress, and until they have been completed it would be unwise to propose any alteration.

Many of the atomic weights given in the table are well known to be more or less uncertain. This is especially true with respect to the rarer elements, such as gallium, indium, columbium, tantalum, etc. But some of the commoner elements also stand in need of revision, and we venture to call attention to a few of these. Among the metals, the atomic weights of mercury, tin, bismuth and antimony should be redetermined, for the reason that the existing data are not sufficiently concordant. Palladium also, on account

of discrepancies between different observers, and possibly vanadium, for which the data are too few, deserve attention. Among the non-metals, phosphorus has been peculiarly neglected; and our knowledge of the atomic weight of silicon rests upon a single ratio. In the latter case, confirmatory data are much to be desired. Upon any of these elements new investigations would be most serviceable.

There is one other point to which we may properly call attention. Many of the ratios from which atomic weights have been calculated, were measured in vessels of glass, by processes involving the use of strong acids. In such cases the solubility of the glass becomes an important consideration, even when no transfer of material from one vessel to another has occurred. A slight conversion of silicate into chloride would cause an increase of weight during the operation, and so introduce an error into the determination. Such errors are doubtless very small, and still they ought not to be neglected. Now that vessels of pure silica, the so-called quartz-glass, are available for use, they might well replace ordinary glass in all processes for the determination of atomic weights. An investigation into the relative availability of the two kinds of glass is most desirable.

(Signed) F. W. Clarke,
T. E. Thorpe,
Karl Seubert,
Henri Moissan,
Committee.

## CHEMICAL SUBSTANCES AND THEIR COMMON NAMES.

| Common Names. | Chemical Names. |
|---|---|
| Alum | Sulphate of aluminum and potassium |
| Aqua fortis | Nitric acid |
| Aqua regia | Nitro-hydrochloric acid |
| Calomel | Mercurous chloride |
| Carbolic acid | Phenol |
| Caustic potash | Potassium hydrate |
| Caustic soda | Sodium hydrate |
| Chalk | Calcium carbonate |
| Copperas | Sulphate of iron |
| Corrosive sublimate | Mercuric chloride |
| Cream of tartar | Bitartrate of potassium |
| Epsom salts | Magnesium sulphate |
| Fire damp | Light carbureted hydrogen, methane |
| Glauber's salt | Sodium sulphate |
| Grape sugar | Glucose |
| Goulard water | Basic acetate of lead |
| Iron pyrites | Sulphide of iron |
| Jewelers' putty | Oxide of tin |
| Laughing gas | Nitrous oxide |
| Lime | Calcium oxide |
| Lunar caustic | Silver nitrate |
| Mosaic gold | Bisulphide of tin |
| Muriatic acid | Hydrochloric acid |
| Plaster of Paris | Calcium sulphate |
| Realgar | Sulphide of arsenic |
| Red lead | Oxide of lead |
| Rochelle salt | Sodium potassium tartrate |
| Sal ammoniac | Ammonium chloride |
| Salt, common | Sodium chloride |
| Salt of tartar (potash) | Potassium carbonate |
| Saltpetre | Potassium nitrate |
| Salts of lemon | Oxalic acid |
| Slaked lime | Calcium hydrate |
| Soda, washing | Sodium carbonate |
| Soda, baking | Sodium bicarbonate |
| Soda | Sodium carbonate |
| Spirits of hartshorn | Ammonia, solution of |
| Spirits of salt | Hydrochloric acid |
| Sugar of lead | Lead acetate |
| Tartar emetic | Potassium antimony tartrate |
| Verdigris | Basic acetate of copper |
| Vermilion | Sulphide of mercury |
| Vinegar | Dilute acetic acid |
| Vitriol, blue | Copper sulphate |
| " green | Ferrous sulphate |
| " oil of | Sulphuric acid |
| " white | Zinc sulphate |
| Volatile alkali | Ammonia |

—*Knowledge Year Book.*

## SPECIFIC GRAVITY.

To Convert Degrees Baumé into Specific Gravity.—(1) For liquids heavier than water: Subtract the degree of Baumé from 145 and divide into 145. The quotient is the specific gravity.

(2) For liquids lighter than water: Add the degree of Baumé to 130 and divide it into 140. The quotient is the specific gravity.

To Convert Specific Gravity into Degrees Baumé.—(1) For liquids heavier than water: Divide the specific gravity into 145 and subtract from 145. The remainder is the degree of Baumé.

(2) For liquids lighter than water: Divide the specific gravity into 140 and subtract 130 from the quotient. The remainder will be the degree of Baumé.

### COMPARISON OF DEGREES TWADDELL AND SPECIFIC GRAVITY.

In order to change degrees Twaddell into specific gravity, multiply by 5, add 1,000 and divide by 1,000.

Example: Change 168 deg. Twaddell into specific gravity.

$$\begin{array}{r} 168\times 5 \\ \hline 840 \\ 1{,}000 \\ \hline 1{,}000)1{,}840 \\ \hline \end{array}$$

1.84, specific gravity.

To change specific gravity into degrees Twaddell, multiply by 1,000, subtract 1,000 and divide by 5.

Example: Change 1.84 specific gravity to degrees Twaddell.

$$\begin{array}{r} 1.84\times 1{,}000 \\ 1{,}840 \\ 1{,}000 \\ \hline 5)840 \\ \end{array}$$

168° Tw.

## SPECIFIC GRAVITY.

Determination of Specific Gravity: Solids: (1) Solids heavier than, and insoluble in water:

*a.* By weighing in air and water.—

$$\text{Sp. gr.} = \frac{\text{(weight in air)}}{\text{(loss of weight in water)}}$$

*b.* By Nicholson's hydrometer. Let $w_1$ be the weight required to sink the instrument to the mark on the stem; to take the specific gravity of any solid substance, place a portion of it weighing less than $w_1$ in the upper pan, with such additional weight, say $w_3$, as will cause the instrument to sink to the zero mark. The weight of the substance is then $w_1 — w_3$. Next transfer the substance to the lower pan, and again adjust with weight $w_4$ to the zero mark.

$$\text{Sp. gr.} = \frac{w_1 - w_3}{w_4 - w_3}$$

*c.* By the specific gravity bottle (applicable to powders). Weigh the flask filled to the mark with water, then place the substance, of known weight, in the flask, fill to the mark with water, and weigh again.

$$\text{Sp. gr.} = \frac{\text{weight of substance in air}}{\text{wt. in air} + \text{wt. of flask and water} - \text{wt. of flask filled with substance and water.}}$$

(2) Solids lighter than and insoluble in water. The solid is weighted with a piece of lead and weighed in water.

$$\text{Sp. gr.} = \frac{\text{(weight of substance in air)}}{\text{(wt. of lead in water)} - \text{(wt. of lead and substance in water)} + \text{(wt. of substance in air)}}$$

(3) Solids heavier than and soluble in water. Proceed as in 1 *a*, using instead of water some liquid without action on the solid.

(weight of bulk of liquid equal to substance) = (weight of substance in air) — (weight of substance in liquid).

$$\text{(wt. of bulk of water equal to substance)} = \frac{\text{(wt. of bulk of liquid equal to substance)}}{\text{(sp. gr. of liquid)}}$$

$$\text{Sp. gr.} = \frac{\text{(weight of substance in air)}}{\text{(weight of bulk of water equal to substance)}}$$

Liquids: (1) By the hydrometer.

(2) By the specific gravity bottle. Weigh the bottle filled to the mark with water, and again when filled to the mark with liquid.

$$\text{Sp. gr.} = \frac{\text{(weight of liquid and bottle)} - \text{(weight of bottle)}}{\text{(weight of water and bottle)} - \text{(weight of bottle)}}$$

Tables of Specific Gravity will be found under Weights and Measures.

## THERMOMETER SCALES.

Much annoyance is caused by the great difference of thermometer scales in use in the different civilized countries. The scale of Reaumur prevails in Germany. As is well known, he divides the space between the freezing and boiling points into 80 deg. France uses that of Celsius, who graduated his scale on the decimal system. The most peculiar scale of all, however, is that of Fahrenheit, a renowned German physicist, who in 1714 or 1715, composed his scale, having ascertained that water can be cooled under the freezing point, without congealing. He therefore did not take the congealing point of water, but composed a mixture of equal parts of snow and sal ammoniac, about —14 deg. R. The conversion of any one of these scales to another is very simple, and easily made. To change a temperature as given by Fahrenheit's scale into the same as given by the centigrade scale subtract 32 deg. from Fahrenheit's degrees, and multiply the remainder by 5-9. The product will be the temperature in centigrade degrees.

To change from Fahrenheit's to Reaumur's scale, subtract 32 deg. from Fahrenheit's degrees, and multiply the remainder by 4-9. The product will be the temperature in Reaumur's degrees.

## COMPARATIVE SCALES OF THERMOMETER.

| C. | R. | F. | C. | R. | F. | C. | R. | F. |
|---|---|---|---|---|---|---|---|---|
| −30 | −24.0 | −22.0 | 14 | 11.2 | 57.2 | 58 | 46.4 | 136.4 |
| −29 | −23.2 | −20.2 | 15 | 12.0 | 59.0 | 59 | 47.2 | 138.2 |
| −28 | −22.4 | −18.4 | 16 | 12.8 | 60.8 | 60 | 48.0 | 140.0 |
| −27 | −21.6 | −16.6 | 17 | 13.6 | 62.6 | 61 | 48.8 | 141.8 |
| −26 | −20.8 | −14.8 | 18 | 14.4 | 64.4 | 62 | 49.6 | 143.6 |
| −25 | −20.0 | −13.0 | 19 | 15.2 | 66.2 | 63 | 50.4 | 145.4 |
| −24 | −19.2 | −11.2 | 20 | 16.0 | 68.0 | 64 | 51.2 | 147.2 |
| −23 | −18.4 | −9.4 | 21 | 16.8 | 69.8 | 65 | 52.0 | 149.0 |
| −22 | −17.6 | −7.6 | 22 | 17.6 | 71.6 | 66 | 52.8 | 150.8 |
| −21 | −16.8 | −5.8 | 23 | 18.4 | 73.4 | 67 | 53.6 | 152.6 |
| −20 | −16.0 | −4.0 | 24 | 19.2 | 75.2 | 68 | 54.4 | 154.4 |
| −19 | −15.2 | −2.2 | 25 | 20.0 | 77.0 | 69 | 55.2 | 156.2 |
| −18 | −14.4 | −0.4 | 26 | 20.8 | 78.8 | 70 | 56.0 | 158.0 |
| −17 | −13.6 | 1.4 | 27 | 21.6 | 80.6 | 71 | 56.8 | 159.8 |
| −16 | −12.8 | 3.2 | 28 | 22.4 | 82.4 | 72 | 57.6 | 161.6 |
| −15 | −12.0 | 5.0 | 29 | 23.2 | 84.2 | 73 | 58.4 | 163.4 |
| −14 | −11.2 | 6.8 | 30 | 24.0 | 86.0 | 74 | 59.2 | 165.2 |
| −13 | −10.4 | 8.6 | 31 | 24.8 | 87.8 | 75 | 60.0 | 167.0 |
| −12 | −9.6 | 10.4 | 32 | 25.6 | 89.6 | 76 | 60.8 | 168.8 |
| −11 | −8.8 | 12.2 | 33 | 26.4 | 91.4 | 77 | 61.6 | 170.6 |
| −10 | −8.0 | 14.0 | 34 | 27.2 | 93.2 | 78 | 62.4 | 172.4 |
| −9 | −7.2 | 15.8 | 35 | 28.0 | 95.0 | 79 | 63.2 | 174.2 |
| −8 | −6.4 | 17.6 | 36 | 28.8 | 96.8 | 80 | 64.0 | 176.0 |
| −7 | −5.6 | 19.4 | 37 | 29.6 | 98.6 | 81 | 64.8 | 177.8 |
| −6 | −4.8 | 21.2 | 38 | 30.4 | 100.4 | 82 | 65.6 | 179.6 |
| −5 | −4.0 | 23.0 | 39 | 31.2 | 102.2 | 83 | 66.4 | 181.4 |
| −4 | −3.2 | 24.8 | 40 | 32.0 | 104.0 | 84 | 67.2 | 183.2 |
| −3 | −2.4 | 26.6 | 41 | 32.8 | 105.8 | 85 | 68.0 | 185.0 |
| −2 | −1.6 | 28.4 | 42 | 33.6 | 107.6 | 86 | 68.8 | 186.8 |
| −1 | −0.8 | 30.2 | 43 | 34.4 | 109.4 | 87 | 69.6 | 188.6 |
| 0 | 0.0 | 32.0 | 44 | 35.2 | 111.2 | 88 | 70.4 | 190.4 |
| 1 | 0.8 | 33.8 | 45 | 36.0 | 113.0 | 89 | 71.2 | 192.2 |
| 2 | 1.6 | 35.6 | 46 | 36.8 | 114.8 | 90 | 72.0 | 194.0 |
| 3 | 2.4 | 37.4 | 47 | 37.6 | 116.6 | 91 | 72.8 | 195.8 |
| 4 | 3.2 | 39.2 | 48 | 38.4 | 118.4 | 92 | 73.6 | 197.6 |
| 5 | 4.0 | 41.0 | 49 | 39.2 | 120.2 | 93 | 74.4 | 199.4 |
| 6 | 4.8 | 42.8 | 50 | 40.0 | 122.0 | 94 | 75.2 | 201.2 |
| 7 | 5.6 | 44.6 | 51 | 40.8 | 123.8 | 95 | 76.0 | 203.0 |
| 8 | 6.4 | 46.4 | 52 | 41.6 | 125.6 | 96 | 76.8 | 204.8 |
| 9 | 7.2 | 48.2 | 53 | 42.4 | 127.4 | 97 | 77.6 | 206.6 |
| 10 | 8.0 | 50.0 | 54 | 43.2 | 129.2 | 98 | 78.4 | 208.4 |
| 11 | 8.8 | 51.8 | 55 | 44.0 | 131.5 | 99 | 79.2 | 210.2 |
| 12 | 9.6 | 53.6 | 56 | 44.8 | 132.8 | 100 | 80.0 | 212.0 |
| 13 | 10.4 | 55.4 | 57 | 45.6 | 134.6 | | | |

To change the temperature as given by the centigrade scale into the same as given by Fahrenheit, multiply the centigrade degrees by 9-5 and add 32 deg. to the product. The sum will be the temperature by Fahrenheit's scale.

To change from Reaumur's to Fahrenheit's scale, multiply the degrees on Reaumur's scale by 9-4 and add 32 deg. to the product. The sum will be the temperature by Fahrenheit's scale.

For those who wish to save themselves the trouble we have calculated the preceding comparative table.

## VALUE OF RARE ELEMENTS.

| Elements. | Quantity. | Value. |
|---|---|---|
| Boron nitrate (New York) | lb. | $1.50 |
| Boron, pure crystals (Germany) | 10 grams | 13.09 |
| Boron, amorphous, pure (Germany) | kilo. | 119.00 |
| Boron, powder (*Moissan*) (Germany) | " | 142.80 |
| Cæsium nitrate crystals (Germany) | 100 grams | 11.90 |
| Cæsium oxide hydrated (Germany) | " | 13.09 |
| Calcium metal, (Germany) | 1 gram | 4.28 |
| Cerium metal, fused (Germany) | " | 2.02 |

VALUE OF RARE ELEMENTS.—*Continued.*

| Elements. | Quantity. | Value. |
|---|---|---|
| Cerium metal, powder (Germany) | 1 gram | $1.67 |
| Cerium nitrate (New York) | lb. | 10.00 |
| Didymium metal, fused (Germany) | 1 gram | 5.47 |
| Didymium metal powder (Germany) | " | 4.71 |
| Didymium nitrate (New York) | lb. | 35.00 |
| Erbium metal (Germany) | 1 gram | 3.09 |
| Erbium nitrate (New York) | lb. | 40.00 |
| Germanium metal, fused (Germany) | 1 gram | 59.50 |
| Germanium metal, powder (Germany) | " | 57.12 |
| Glucinum metal, crystals (Germany) | " | 9.04 |
| Glucinum metal, fused in balls (Germany) | " | 35.70 |
| Glucinum metal, powder (Germany) | " | 5.95 |
| Glucinum nitrate (New York) | lb. | 20.00 |
| Iridium metal, fused (Germany) | 10 grams | 10.71 |
| Iridium metal, powder (Germany | " | 9.52 |
| Lanthanum metal, powder (Germany) | 1 gram | 4.28 |
| Lanthanum metal, in balls (Germany) | " | 9.04 |
| Lanthanum nitrate (New York) | lb. | 30.00 |
| Lithium metal, pure (Germany) | 1 gram | 0.71 |
| Lithium metal, chem. pure (Germany) | " | 2.38 |
| Lithium carbonate (New York) | lb. | 1.50 |
| Lithium nitrate (New York) | oz. | .60 |
| Magnalium metal, ingot (Germany) | kilo. | 3.57 |
| Magnalium metal, sheet (Germany) | " | 7.14 |
| Magnesium metal, ingot (Germany) | " | 4.28 |
| Magnesium metal, ribbon, wire, sheet (Germany) | " | 7.62 |
| Magnesium metal, sticks (Germany) | " | 5.47 |
| Magnesium metal, cubes (Germany) | " | 5.00 |
| Magnesium metal, powder (Germany) | " | 3.81 @ 5.00 |
| Manganese metal, pure fused (Germany) | " | 3.81 |
| Manganese metal, com'l (94 @ 97%) (Germany) | " | 1.25 |
| Molybdenum metal, pure (Germany) | " | 17.85 |
| Molybdenum metal, com'l, fused (Germany) | " | 6.66 |
| Molybdenum metal, pure, fused (Germany) | 100 grams | 9.52 |
| Molybdenum metal, powder (Germany) | kilo. | 4.05 |
| Niobium metal, pure (Germany) | 1 gram | 4.71 |
| Osmium metal (Germany) | 10 grams | 17.14 |
| Palladium metal (Germany) | " | 8.57 |
| Platinum (New York) | oz. | 18.50 |
| Polonium | —— | Speculative.* |
| Potassium metal in balls (Germany) | kilo. | 16.60 |
| Radium | See Radi | um, p. 449† |
| Rhodium metal (Germany) | 10 grams | 26.18 |
| Rubidium metal pure (Germany) | 1 gram | 4.76 |
| Ruthenium metal, powder (Germany) | " | 2.38 |
| Ruthenium metal, sponge (Germany) | " | 4.28 |
| Selenium metal (Germany) | kilo. | 16.66 |
| Silicium metal, com'l, fused (Germany) | " | 9.52 |
| Sodium metal (New York) | lb. | 0.50 |
| Strontium metal (Germany) | 1 gram | 6.19 |
| Strontium nitrate (New York) | lb. | 0.08 |
| Tantalum metal, pure (Germany) | 1 gram. | 3.57 |
| Tellurium metal, chem. pure sticks (Germany) | kilo. | 106.10 |
| Tellurium metal, chem. pure powder (Germany) | " | 107.10 |
| Thallium metal (Germany) | " | 23.80 |
| Thorium nitrate (New York) | lb. | 4.50 |
| Titanium metal, pure (Germany) | kilo. | 23.80 |
| Uranium metal (Germany) | " | 190.40 |
| Uranium nitrate (New York) | oz. | 0.25 |
| Wolfram metal, powder for steel makes (Germany) | kilo. | 1.79 |
| Yttrium metal (Germany) | 1 gram | 3.33 |
| Zirconium metal (Germany) | kilo. | 95.20 |
| Zirconium nitrate (New York) | lb. | 8.00 |

* The value of polonium is purely speculative. Minute quantities have been sold at very high prices. It is worth 75 cents a gram on bismuth and platinum plates. The quantity of polonium is of course very minute.

† The supply is so small that any price can be asked. $3,500,000 is the current "newspaper" estimate per pound. See Radium, page 449.

[Table furnished by the *Engineering and Mining Journal.*]

## RADIUM AND RADIO-ACTIVITY.

The marvels of radium may be said to have been more or less foreshadowed by the discovery of the Roentgen rays. It was immediately determined that the emanations of a Crookes tube were not ethereal undulations such as ordinary light, but that they consisted of actual material particles of matter highly charged with electricity. Naturally the attempt was made to discover whether the phenomena of phosphorescent substances were not akin to those of the Crookes tube. The leading spirit in this movement was Professor Henri Becquerel, who selected the metal uranium as the subject of his experiments. He accidentally discovered that the so-called phosphorescent attributes of uranium were not due to the absorption of sunlight, but that the substance was spontaneously active, and that the light which came from radium was a new kind of emanation entirely different from the X-rays. To these new radiations the name "Becquerel Rays" was given.

Uranium is obtained from pitchblende, an ore more or less widely distributed through the world, but found chiefly in Bohemia and in Cornwall. Madame Curie, who, at the time Becquerel was making his investigations, was a senior student at the Municipal School of Physics and Technical Chemistry in Paris, had selected "Radio-Activity"—a name which she coined—as the subject of her Doctor's thesis. Naturally it was necessary for her to study uranium and similar minerals with some care. She found that, after having extracted all the uranium contained in her specimen of pitchblende, there still remained in the residue a substance far more active than uranium. After isolating this unknown radiant substance and analyzing it, she found that it contained two new elements. The one she christened "polonium," after Poland, the land of her birth; the other she named "radium."

Several tons of pitchblende must be treated and concentrated before a few grains of radium are obtained. But those few grains are worth more than any precious gem or metal in the world. Indeed they have almost any value which their fortunate possessor may choose to give them. There are probably not two pounds of pure radium in existence; but at the present market price they would be worth each at the very least several million dollars. There is more gold in sea water than radium in pitchblende; and that is why its price is so high.

The properties of radium will probably necessitate a decided revision in some time-honored chemical theories; for radium refuses to conform to our long-established atomic theories, and behaves in a most inexplicable fashion. In the first place the radio-activity of the element has been found to consist of three distinct sets of emanations, which have been respectively christened the Alpha, the Beta, and the Gamma rays, for want of better names.

The Alpha rays are not, like ordinary light, ethereal pulsations, but actual material particles hurled off at a speed of about 20,000 miles per second from the parent mass. They are highly charged with positive electricity. Their speed is about 40,000 times greater than that of a rifle bullet.

The Beta rays, which consist of particles of matter, corpuscles of electricity or "electrons" as the modern physicist calls them, move still more swiftly. Each of the Beta particles (very much smaller in size than the Alpha particles) travels at the rate of about 100,000 miles a second. They are the fastest moving objects known in the universe; for their speed is three hundred times faster than that of the swiftest star. Such is their velocity that it takes a foot of solid iron to stop them.

The Gamma rays are probably Roentgen rays, if one may judge by the similarity of the properties of the two. Like the Beta rays, the Gamma emanations have remarkable penetrating properties. But of the three kinds of rays discharged by radium, the Gamma rays are the most difficult to detect and the least perfectly understood.

Professor Curie, Madame Curie's husband, has discovered that radium constantly maintains a temperature of about five or six degrees above the surrounding atmosphere. For some time this startling phenomenon baffled physicists. Here was a substance constantly giving off heat without being apparently consumed, and without anything to make it hot. It is now thought that this strange property can be explained by assuming that the particles collide with one another, and that the heat generated by the impact (a heat that must be very marked when it is considered how enormous

is the energy of a particle moving at the rate of many thousand miles a second) is sufficient to explain the heat generated by radium.

The fact that radium is a spontaneous source of thermal energy is in itself a fact sufficiently startling. Sir William Ramsay, however, has discovered still other startling properties of this startling substance. He collected the material particles which are shot from the substance, analyzed them, and found that after a few days they changed into helium, a gas which was first discovered burning in the sun. This seems dangerously like the transmutation of one element into another, the problem on the solution of which the medieval alchemist had worked for centuries. After ages of labor seventy-odd bits of primordial matter had been wrung from the earth, so simple and so unchangeable in their nature that they were deemed elements. And now one of them proves to be nothing but the product of another. Can we ever be certain again that the rest are not also likely to change? Is it any wonder that our chemistry needs revision?

The atomic weight of radium has been ascertained by Madame Curie to be 225; that of helium is 2.2. In other words, every atom of radium breaks up into about 100 parts of helium. What becomes of the old teaching that atoms are indivisible particles of matter? Some of the more advanced thinkers have abandoned the atom and adopted the "electron" as the ultimate unit. The atom is certainly quite inadequate to account for the properties of radium. Atoms may be said to be composed of electrons moving, like miniature solar systems, with inconceivable rapidity in well-defined orbits. Sometimes a little planet of that system becomes unstable, darts off with terrific speed like a comet, and thus gives rise to the phenomena of radium, of uranium, and of every other radioactive substance.

Has radium any practical value? it may be asked. So far it is more of a scientific curiosity than anything else. Still, it is not without some use. It is an excellent detector of false diamonds; for it causes the real gem to glow with wonderful brilliancy, while the paste imitation is left comparatively lusterless. Then, again, radium kills bacteria and even very small animals. The modern physician has used the substance with some success in treating certain diseases, among them cancer and lupus. Living tissues of the body are strangely affected by short exposures to the substance. Sores are produced, like burns, which heal only after weeks have elapsed. An electroscope has also been invented, the underlying principle of which is dependent upon the properties of radium.

PRICES OF FRENCH RADIUM, JULY, 1904.

| Form. | Activity. | Price per Gramme. | Price per Ounce. | Price per Milligram. |
|---|---|---|---|---|
| | | Dollars | Dollars | Dollars |
| Radium chloride or bromide | 50 | 4 | 125 | .004 |
| | 100 | 8 | 250 | .008 |
| | 500 | 30 | 910 | .040 |
| | 1,000 | 60 | 1,820 | .080 |
| | 5,000 | 240 | 7,280 | .40 |
| | 10,000 | 500 | 15,050 | .80 |
| | 20,000 | 1,000 | 30,100 | 1.60 |
| | 50,000 | 2,000 | 60,200 | 4.00 |
| | 100,000 | 4,000 | 120,400 | 8.00 |
| | 500,000 | 20,000 | 602,000 | 40.00 |
| Radium, pure | 1,800,000 | 80,000 | 2,408,000 | 144.00 |

—Table furnished by Dr. George F. Kunz.

## MELTING POINTS OF CHEMICAL ELEMENTS.

The melting points of chemical elements are, in many cases, somewhat uncertain, owing to the different results obtained by different observers. This table gives the probable average value.

| Substance. | Melting Point, Degrees C. | Substance. | Melting Point Degrees C. |
|---|---|---|---|
| Aluminum | 625 | Magnesium | 775 |
| Antimony | 435 | Manganese | 1900 |
| Bismuth | 268.1 | Mercury | −39.04 |
| Bromine | −7.27 | Nickel | 1500 |
| Cadmium | 318 | Osmium | 2500 |
| Cæsium | 26.5 | Nitrogen | −208 |
| Chlorine, liquid | −102 | Palladium | 1600 |
| Cobalt | 1650 | Phosphorus | 44.25 |
| Copper | 1100 | Platinum | 1900 |
| Gallium | 30.15 | Potassium | 60 |
| Germanium | 900 | Rhodium | 2000 |
| Gold | 1080 | Rubidium | 38.5 |
| Indium | 176 | Ruthenium | 1800 |
| Iodine | 112 | Selenium | 217 |
| Iridium | 2225 | Silver | 950 |
| Iron, pure | 1635 | Sodium | 97.6 |
| " white pig | 1075 | Sulphur | 115.1 |
| " gray pig | 1200 | Tellurium | 470 |
| Steel | 1360 | Thallium | 289 |
| " cast | 1375 | Tin | 230 |
| Lead | 326 | Zinc | 415 |
| Lithium | 180 | | |

## BOILING POINTS OF CHEMICAL ELEMENTS.

| Substance. | Boiling Point, Degrees C. | Substance. | Boiling Point Degrees C. |
|---|---|---|---|
| Antimony | 1535 | Oxygen | −183 |
| Arsenic | 449 | Ozone | −106 |
| Bismuth | 1413 | Phosphorus | 288 |
| Bromine | 62.08 | Potassium | 695 |
| Cadmium | 779 | Selenium | 675 |
| Chlorine | −33.6 | Sodium | 825 |
| Iodine | over 200 | Sulphur | 448.1 |
| Lead | about 1,525 | Thallium | 1700 |
| Magnesium | 1100 | Tin | about 1,550 |
| Mercury | 357 | Zinc | 958 |
| Nitrogen | −194.4 | | |

## HEAT OF COMBUSTION.

Heat of combustion of some common organic compounds.
Products of combustion, $CO_2$ or $SO_2$ and water, which is assumed to be in a state of vapor.

| Substance. | Therms per Gramme of Substance. | Substance. | Therms per Gramme of Substance. |
|---|---|---|---|
| Acetylene | 11,923 | Gas: | |
| Alcohols: | | Methane | 13,063 |
| Amyl | 8,958 | Naphthalene | 9,618–9,793 |
| Ethyl | 7,183 | Gunpowder | 720–750 |
| Methyl | 5,307 | Oils: | |
| Benzene | 9,977 | Lard | 9,200–9,400 |
| Coals: | | Olive | 9,328–9,442 |
| Bituminous | 7,400–8,500 | Petroleum, American crude | 11,094 |
| Anthracite | 7,800 | " " refined | 11,045 |
| Lignite | 6,900 | " Russian | 10,800 |
| Coke | 7,000 | Woods: | |
| Carbon disulphide | 3,244 | Beech with 12.9 per cent. $H_2O$ | 4,168 |
| Dynamite, 75 per cent | 1,290 | Birch " 11.83 " " " | 4,207 |
| Gas: | | Oak " 13.3 " " " | 3,990 |
| Coal gas | 5,800–11,000 | Pine " 12.17 " " " | 4,422 |
| Illuminating | 5,200–5,500 | | |

SIZES OF DRY PLATES.

| | |
|---|---|
| $3\frac{1}{4} \times 4\frac{1}{4}$ inches | $8 \times 10$ inches |
| $4 \times 5$ " | $10 \times 12$ " |
| $4\frac{1}{4} \times 5\frac{1}{2}$ " | $11 \times 14$ " |
| $4\frac{1}{4} \times 6\frac{1}{2}$ " | $14 \times 17$ " |
| $4\frac{1}{4} \times 6\frac{1}{2}$ " | $16 \times 20$ " |
| $5 \times 7$ " | $17 \times 20$ " |
| $5 \times 8$ " | $18 \times 22$ " |
| $6\frac{1}{2} \times 8\frac{1}{2}$ " | $20 \times 24$ " |

SIZES IN FRANCE AND GERMANY.

| | |
|---|---|
| $6\frac{1}{2} \times 9$ cm | $2.5 \times 3.6$ inches |
| $9 \times 12$ " | $3.6 \times 4.7$ " |
| $12 \times 15$ " | $4.7 \times 5.9$ " |
| $13 \times 18$ " | $5.1 \times 7.0$ " |
| $12 \times 20$ " | $4.7 \times 7.8$ " |
| $15 \times 21$ " | $5.9 \times 8.2$ " |
| $15 \times 22$ " | $5.9 \times 8.6$ " |
| $18 \times 24$ " | $7.0 \times 9.4$ " |
| $21 \times 29$ " | $8.2 \times 10.6$ " |
| $24 \times 30$ " | $9.4 \times 11.8$ " |
| $27 \times 33$ " | $10.6 \times 12.9$ " |
| $27 \times 35$ " | $10.6 \times 13.7$ " |
| $30 \times 40$ " | $11.8 \times 15.7$ " |
| $40 \times 50$ " | $15.7 \times 19.6$ " |
| $50 \times 60$ " | $19.6 \times 23.6$ " |

SIZES IN ITALY.

| | |
|---|---|
| $9 \times 12$ cm | $3.6 \times 4.7$ inches |
| $12 \times 16$ " | $4.7 \times 6.3$ " |
| $12 \times 18$ " | $4.7 \times 7.0$ " |
| $13 \times 18$ " | $5.1 \times 7.0$ " |
| $12 \times 20$ " | $4.7 \times 7.8$ " |
| $18 \times 24$ " | $7.0 \times 9.4$ " |
| $21 \times 29$ " | $8.2 \times 10.6$ " |
| $24 \times 30$ " | $9.4 \times 11.8$ " |
| $27 \times 33$ " | $10.6 \times 12.9$ " |
| $30 \times 36$ " | $11.8 \times 14.1$ " |
| $40 \times 50$ " | $15.7 \times 19.6$ " |
| $50 \times 60$ " | $19.6 \times 23.6$ " |

AIR.—The following data are useful in calculations relating to air:

1. To find the quantity of nitrogen by volume corresponding to 1 volume of oxygen, multiply by 3.770992.

2. To find the quantity of oxygen by volume corresponding to 1 volume of nitrogen, multiply by 0.265182.

3. To find the quantity of nitrogen by weight corresponding to 1 part by weight of oxygen, multiply by 3.313022.

4. To find the quantity of oxygen by weight corresponding to 1 part by weight of nitrogen, multiply by 0.301839.

5. To find the quantity of nitrogen by volume corresponding to 1 part by weight of oxygen, multiply by 2.6365411.

6. To find the quantity of oxygen by volume corresponding to 1 part by weight of nitrogen, multiply by 0.2730071.

7. To find the quantity of nitrogen by weight corresponding to 1 part by volume of oxygen, multiply by 3.6629154.

8. To find the quantity of oxygen by weight corresponding to 1 part by volume of nitrogen, multiply by 0.3792848.

TO TEST AIR FOR SEWER GAS. — Saturate unglazed paper with a solution of 1 oz. of pure lead acetate in half a pint of rain water; let it partially dry, then expose in the room suspected of containing sewer gas. The presence of the latter in any considerable quantity soon darkens or blackens the test paper.

# CHAPTER II.

## ASTRONOMY.

THE TELESCOPE.—Telescopes are of two kinds, namely, *refracting* and *reflecting* telescopes. The refracting telescope consists of an object-glass which forms an image of the object, and an eye-glass by which the image is viewed. The reflecting telescope consists of a *concave mirror* which receives light from the distant object, and reflects it so that the rays converge to a focus and form an image, the image being viewed by an eye-glass. The terrestrial telescope consists of two telescopes like the preceding—which are called astronomical telescopes, and give an inverted image—the second inverting the inverted image of the first, and so giving an upright image. Eye-pieces generally have two lenses, and have names according to the position of the focus. Ramsden's eye-piece has two lenses, the focus being just beyond the field lens. It is called a *positive* eye-piece, and it can be used as a magnifying glass. Huyghens' eye-piece also has two lenses, the focus being between the two. It is called a *negative* eye-piece, and cannot be used as a magnifying glass. These compound eye-pieces enable us to get rid of *spherical* and *chromatic* aberration. The achromatic object-glass is made by joining together two lenses, one of flint glass and the other of crown glass. The dispersion is made equal and opposite, but the bending powers are unequal. A lens is equivalent to a number of prisms placed base to base, the outer prisms having a greater angle to cause the rays to bend more, so that all the rays may come to one point, called the focus. The magnifying power of a telescope is found by dividing the focal length of the object-glass by the focal length of the eye-piece.

THE EQUATORIAL TELESCOPE.—The *equatorial* is an ordinary telescope, mounted in such a way that it can easily be directed to any part of the heavens. The *polar* axis is parallel to the earth's axis, that is to say, it is inclined at an angle equal to the latitude of the place, at Washington about 39°, at London about 51½°. The telescope can be moved round the polar axis in a plane which is parallel to the earth's equator, and this motion is said to be motion in *right ascension*. The telescope can also be moved up and down in a plane at right angles to the earth's equator, and this motion is called motion in *declination*. Whatever part of the skies an object is in, the equatorial can be directed to it, and the object can be kept constantly in view, because there is a kind of clock which drives the instrument round at the same speed at which the earth is turning round.

THE TRANSIT INSTRUMENT.—The transit instrument is a telescope mounted on a horizontal axis, so as to be capable of moving in the meridian only. It is used to determine the exact moment at which celestial bodies cross the *meridian*, that is, when they are in a true north or south position. It is also used for determining the *declination* of celestial objects, that is, how far in angular measures these bodies are from the celestial equator.

THE SIDEREAL CLOCK.—The sidereal clock is similar to an ordinary clock, but it is regulated to keep accurate time with the apparent diurnal movements of the stars, instead of with the mean sun. It shows the same time as clocks and watches only once in a year, namely, at the Vernal Equinox, about the 21st of March. It gains about four minutes each day on the ordinary clock, and in a year it gains a whole day, so that there are 366 sidereal days and only 365 solar days in one year. The sidereal noon occurs when the first point of Aries passes the meridian, and the hours are reckoned from 0 to 24. The time by the sidereal clock at which a celestial body crosses the meridian is equal to the right ascension of that particular object. Conversely, if the exact right ascension of a star be known, the error of the clock can be determined by observing a transit of the star.

THE CHRONOGRAPH.—The chronograph consists of a cylinder covered with paper, and made to rotate uniformly by clockwork. It is connected electrically with the sidereal clock, which, as it ticks, makes dots on the paper at equal distances by means of a recording pen, and these dots represent seconds. Fractions of a second are recorded by the observer touching a key, which causes a second pen to make a dot on the cylinder as it turns round. This dot would come between two second dots, and the distance is measured from these. In this manner the $\frac{1}{100}$ or $\frac{1}{1000}$ of a second can be estimated. The small fractions of a second obtained by the chronograph are necessary in fixing the right ascension and declination by the transit instrument.

THE MICROMETER.—The micrometer is used for measuring small *arcs*. It consists of two *wires*, which can be brought together or separated at pleasure by means of a screw. An equatorial star appears to move through about 15° in one hour, 1° in four minutes, 15′ in one minute, or 15″ of arc in one second of time. The distance that the wire moves for one turn of the screw is found by allowing a star to pass from one wire to

the other, and then allowing 15″ of arc for every second of time taken in so doing. The diameter of the moon, the sun, or a planet can be estimated in angular measure by the micrometer, and then, knowing the distance of these objects, their size can be calculated from a knowledge of the relation that exists between the radius of a circle and its circumference.

The Theodolite.—The theodolite is used for measuring horizontal and vertical angles, that is, altitude and azimuth. It consists of a small telescope, which can be moved up and down, and the inclination is shown by a graduated circle, called the altitude circle. The telescope can also be twisted around a vertical axis, and the angular distances of objects from the north point of the horizon measured, that is, *azimuth*.

The Sextant.—The sextant is chiefly employed on board ship for observing the altitude of the sun, lunar distances, etc., in the determination of latitude and longitude. It consists of a telescope, through which the observer looks. Opposite to the telescope is a mirror, half silvered and half plain, so that he can see directly through the plain part to an object, and he can bring a second object to coincide with the first by means of a second mirror attached to the movable arm, which reflects its light on to the silvered part of the first mirror, and from thence through the telescope. The reading on the sextant then gives the angular distance between the two objects.

Verniers.—Verniers are divided scales, with their divisions a little smaller than those on the main scale to which they are attached. If a length equal to nine divisions of the main scale be divided into ten parts, then each of these latter will be $\frac{1}{10}$ less than the former. In general, $n$ divisions of the vernier are equal to $n - 1$ divisions of the scale, which enables us to read to the $n$th part of a division, whatever that may be. If the divisions on the main scale were tenths of an inch we could get hundredths by dividing a length equal to nine of them into ten parts, then the difference between the lengths of these would be $\frac{1}{10}$ of $\frac{1}{10}$ of an inch, that is, $\frac{1}{100}$.

Angular Measurement.—The measurement of the distances of the sun, moon, and planets depends upon our knowledge of the properties of triangles. Our knowledge of the size of the earth and other bodies in space depends upon angular measurement. Our knowledge of the mass, volume, and density of the sun, moon, and planets, and even the masses and distances of some of the stars, depends upon our ability to measure angles.

Measurement of Time.—An ancient method of measuring time was by the *gnomon*, an upright stick in the ground which cast a shadow of the sun, the length and position of which varied according to the time of day, hence the sun-dial. Other methods consisted in chanting psalms, burning candles, and dropping water or sand from one vessel to another, hence *clepsydra* and *hour-glass*, etc. Clocks came into use in England in the fourteenth century; but instead of a pendulum a vibrating horizontal bar was employed—DeWyck's clock. Galileo discovered the pendulum, which suggested itself to him by observing a swinging lamp in the Cathedral of Pisa. Huyghens found that the vibrations of a pendulum were not equal for any length of swing; hence the introduction of the *cycloidal* pendulum. Hooke's anchor escapement was the next advance, which allowed of a smaller arc of swing and eliminated a certain amount of friction, but it is not used in the best clocks because of the *recoil*. Graham overcame the recoil just mentioned by using pallets whose surfaces were arcs of circles, hence *dead-beat escapement*. The chronometer escapement has a balance-wheel in place of a pendulum, which thus admits of a more compact arrangement than is possible in a clock with a pendulum; moreover, it will work in any position.

Altitude and Azimuth.—The altitude of a celestial object, as a star, is its angular height above the horizon, and its complement—or that which is required to make it equal to a right angle—is called the *zenith distance*. The azimuth of a celestial object is its angular distance from the north point of the horizon. It is found by drawing an imaginary arc from the zenith point through the object till it cuts the horizon, and then measuring the angular distance between this point and the north point.

The Sphere of Observation.—The appearance of the starry sphere presents different aspects, depending upon the locality of the observer. At Washington the north pole is elevated about 39° above the horizon, at London about 51½° above the horizon; this elevation of the pole always being equal to the latitude of the place of observation. The celestial equator being 90° distant from the pole, will cut the horizon of London at an angle of 38½°, and that of Washington at about 51°, the northern side in each case being depressed below, and the southern side elevated above, the horizon.

Parallax.—The moon's place, when looked at through a telescope from London and some distant place, as Cape Town, seems to change—that is, the telescopes contain an angle. This contained angle is less when the sun is viewed in the same way, but when stars are looked at similarly the angle disappears altogether—that is, stars have no parallax, while the sun, moon, and planets have parallax, or angular displacement caused by change of position.

Rotundity of the Earth.—The concave heavens; the disappearance of a ship at sea; the extension of the horizon as we ascend high elevations; the frequent circumnavigation of the globe; the earth's shadow cast by the sun upon the moon during an eclipse; the spherical form of the sun, moon, and planets—all confirm our belief that the earth is globular in form.

Magnitude of the Earth.—The size of the earth is found by observing a star in the exact zenith of any place, then traveling along a direct north line, till the star has declined 1° from the zenith, and measuring the distance traversed. This distance would be the length of 1° in miles, and 360 times that length would give the circumference of the earth.

Demonstration of Earth's Rotation.—A heavy body set in motion tends to retain its original plane of motion. Foucault's pendulum consists of a heavy ball at the

end of a long wire, supported by a steel pivot on an agate plane. The ball, when set swinging, seems to change its direction of swing across a graduated circle on a table beneath it, but, as we know that the pendulum tends to keep to the same plane of motion, and that there is so little to prevent it from doing so, we conclude it is the earth which is turning on its axis and carrying the table with it. The gyroscope is essentially the same as the pendulum, a heavy rotating disk taking the place of the swinging bob of the pendulum. The rotating disk is supported inside a horizontal ring, this ring being in its turn supported by knife edges resting on steel plates in the circumference of a vertical ring, and this vertical ring is supported by a torsionless thread, so that all the parts are nicely counterpoised and are free to move. A pointer attached to the vertical ring is found to move over a graduated scale at the same rate as the pendulum changed its plane of motion; hence, we conclude that it is the earth which moves, because we know that the rotating disc holds to its initial plane of motion. The rotation of the earth on its axis furnishes us with an invaluable *unit of time.*

Revolution of the Earth in its Orbit.—The stars which are seen nearest to the sun after sunset at different times of the year are not the same, but belong to different signs of the zodiac. This change of position of the sun with respect to the stars takes place at the rate of about 1° a day, so that the whole heavens appear to revolve once in a year independent of their diurnal revolution. This is due to the real revolution of the earth in its orbit. The stars appear to describe little ellipses in the course of a year, but, as a matter of fact, it is the light coming from the stars that is displaced by the motion of the earth in its orbit, the form of this orbit being elliptical, so that the star's position is changed in such a way as to project an ellipse similar to that which the earth traces out. This phenomenon is known as the *aberration of light*, and was discovered by Bradley.

Velocity of Light.—Fizeau determined the velocity of light by reflecting a spot of light from a mirror at one station to a second mirror at a distant station. The light was brought to a focus at the required points by means of lenses. A toothed wheel whose revolutions could be registered was so placed that its teeth revolved in the focus, and the spot of light could be seen between two teeth. It was possible to turn the wheel so quickly that the spot of light was stopped by a tooth coming up before it could pass through. The distance between the stations being known, and the rate at which the wheel turned, the velocity of light could be found. Foucault's method consisted of a rapidly rotating mirror, on which a beam of light was admitted through a slit. It was then reflected on to a lens, after which it was brought to a focus on a concave mirror at some distance. It was found possible to turn the mirror so quickly that it moved through a small angle before the spot of light returned. The distance between the mirrors, the rate of rotation of the mirror, and the amount of displacement being known, the velocity of light could be estimated. The velocity of light and the aberration angle being known the sun's distance can be found.

(1) The ratio of the velocity of light and the earth in its orbit as determined by observation is as 10,089 : 1.

(2) The earth completes its orbit in 365¼ days.

(3) Light would do the same journey in $\frac{365\frac{1}{4}}{10,089}$ days.

(4) Knowing the time it would take to complete the revolution we can find how long it would take to cross the diameter, and therefore the radius.

(5) We multiply the number of seconds taken by light to cross the radius of the earth's orbit by the velocity of light, and it gives us 92,628,000 miles as the sun's distance.

The Sun not always at the Same Distance from the Earth.—In the *Nautical Almanac* the sun's apparent diameter is given for every day in the year. The apparent diameter was 32′35.2″ on January 3rd, 1904, and on July 4th of the same year it was only 31′30.7″. This proves the sun is farther away from us in summer than in winter.

Perihelion and Aphelion.—When the earth is nearest to the sun it is said to be in *Perihelion*, and when farthest from the sun it is said to be in *Aphelion.*

The Earth Moves with varying Velocity in its Orbit.—This is ascertained by measuring the sun's longitude for two successive days at different times of the year, by which means it is found in December to move over 61′10.0″ within a period of twenty-four hours, while in June it only moves over 57′10.8″ in the same time.

Kepler's Law of Equal Areas.—Kepler found that the line joining the center of the sun with the center of the earth moved over equal areas in equal times, that is, the greater distance of the earth from the sun in June compensated for the smaller arc of motion in longitude, so that lines drawn from the sun to the extremities of the arcs moved over make equal triangles.

How the Inclination of the Ecliptic to the Plane of the Earth's Equator is Determined.—The elevation of the sun above the horizon is measured by the shadow cast by the gnomon, or the north polar distance is ascertained by the transit instrument for each day in the year. In either case the sun will be found to oscillate backwards and forwards over an arc of about 47°, half of which arc is the inclination of the ecliptic to the equator.

Nodes.—The two points where the plane of the ecliptic crosses the plane of the celestial equator or equinoctial are called *nodes*, that point at which the sun appears to come up from below the equator being called the *ascending node*, and that at which the sun appears to descend from above the same plane being called the *descending node.*

The First Point of Aries.—The *ascending node* above referred to is the *first point of Aries.* It is universally used by astronomers for fixing the longitudinal and right ascension of celestial bodies.

The Sidereal, Solar, and Mean Solar Day.—The sidereal day is the interval which elapses between two successive appearances of the same star on the meridian. The solar

day is the interval which elapses between two successive appearances of the sun on the meridian, but these are not of the same length. The mean solar day is the interval of time obtained by adding all the solar days in a year together, and then dividing by the number of days in a year.

EQUATION OF TIME.—The inequality of the solar days arises from two causes, namely, the *obliquity of the ecliptic to the equator*, and the *unequal velocity of the earth in its orbit*. The *equation of time* is the *algebraic sum* of these two variables—that is to say, sometimes they both cause the sun to come too soon to the meridian; at other times one causes the sun to come up too soon and the other too late. In the former case the sum of the two corrections, and in the latter case the difference of the two corrections, is the equation of time, and so on.

THE SEASONS.—The seasons are the result of the revolution of the earth in its orbit and the inclination of the ecliptic to the equator. The sun on this account attains different heights above the horizon, giving different lengths of day and night. By reason of its giving to the earth more heat in the day than it loses by radiation in the night, and *vice versa*, we have summer or winter as the case may be.

THE YEAR.—The ordinary or *tropical* year is the period which elapses between two successive appearances of the sun at the vernal equinox. The *anomalistic* year is the period which elapses between two successive returns of the sun to his *perigean* point. The *sidereal* year is the time which elapses between two successive appearances of the same star on the meridian at the same time of day.

PRECESSION AND NUTATION.—The sun and moon attract the protuberant portion of the earth's equator more on that side nearest to them than on that side farthest away, and in this way the differential attraction tends to tilt the axis a little, so that it describes a circle in about 25,800 years. The moon's differential attraction is greater than that of the sun. On account of the moon continually changing its relation to the earth's equator, it causes the axis of the earth to describe a circle with a wavy circumference, to which effect the term *nutation*, or nodding of the earth's axis, is applied.

ASTRONOMICAL SYMBOLS AND ABBREVIATIONS.

| | | | | | |
|---|---|---|---|---|---|
| ☉ | The Sun. | ° | Degrees. | | |
| ☾ | The Moon. | ′ | Minutes of Arc. | | |
| ☿ | Mercury. | ″ | Seconds of Arc. | | |
| ♀ | Venus. | N. | North. | S. | South. |
| ⊕ or ♁ | The Earth. | E. | East. | W. | West. |
| ♂ | Mars. | | | | |
| ♃ | Jupiter. | 0. | ♈ Aries. | 0 | |
| ♄ | Saturn. | I. | ♉ Taurus. | 30 | |
| ♅ | Uranus. | II. | ♊ Gemini. | 60 | |
| ♆ | Neptune. | III. | ♋ Cancer. | 90 | |
| ☌ | Conjunction. | IV. | ♌ Leo. | 120 | |
| □ | Quadrature. | V. | ♍ Virgo. | 150 | |
| ☍ | Opposition. | VI. | ♎ Libra. | 180 | |
| ☊ | Ascending Node. | VII. | ♏ Scorpio. | 210 | |
| | | VIII. | ♐ Sagittarius. | 240 | |
| ☋ | Descending Node. | IX. | ♑ Capricornus. | 270 | |
| | | X. | ♒ Aquarius. | 300 | |
| | | XI. | ♓ Pisces. | 330 | |

h Hours.
m Minutes of Time.
s Seconds of Time.

LATITUDE, LONGITUDE, RIGHT ASCENSION, AND DECLINATION.—Terrestrial latitude is measured from the equator to the poles, north and south. Terrestrial longitude is, in England, measured from the meridian of Greenwich, but other countries use their own meridians. Right ascension is measured from the first point of Aries. Declination is measured from the celestial equator. Celestial longitude is measured from the first point of Aries. Celestial latitude is measured from the ecliptic.

VARIATION IN THE LENGTH OF DEGREES OF LATITUDE.

| Country. | Latitude. | Length of Degree in Feet. | Observer. |
|---|---|---|---|
| | ° ′ ″ | | |
| Sweden. . . | N. 66 20 10 | 365,744 | Maupertuis |
| Denmark.. | N. 54 8 13.7 | 365,087 | Schumacher |
| England . | N. 52 35 45 | 364,971 | Roy |
| India .... | N. 12 32 20.8 | 362,956 | Lambton |
| Peru..... | S. 1 31 0.4 | 362.790 | Lacondamine |
| Cape of GoodHope | S. 33 18 30 | 364,713 | Lacaille |

MEASUREMENT OF THE SIZE OF THE SUN AND PLANETS.—The ratio between the radius of a circle and its circumference is always the same, no matter how large or small the circle may be. Thus, an arc of 57.2958° on any circle is equal in length to the radius of that circle; and if this be reduced to seconds of arc, we get 206,265″ as the number of seconds in a length of arc equal to radius. The mean angular diameter of the sun, as measured by the micrometer, is a little over 32′ of arc. We may consider the sun to form part of the circumference of a circle, with its distance from the earth as radius. There are 1920″ in 32′, and $\frac{206,265}{1920} = 108$ nearly; hence the distance of the earth from the sun is 108 times the diameter of the sun, whatever that may be. But we know the distance of the sun to be 92,885,000 miles; so that the diameter of the sun must be $\frac{92,885,000}{108} = 860,000$ miles.

The same method applies to the planets and their satellites as well as to the sun. The angular diameter of the body being measured in seconds of arc, it bears the same ratio to 206,265 (the number of seconds in a length of arc equal to radius) that the diameter in miles bears to the distance in miles; or, calling the actual diameter $d$, and the real distance D, we have $d = \frac{D \times \text{angular diameter}}{206,265}$. For example—the moon, in round numbers, is 240,000 miles distant, and its angular diameter is a little over 31′; hence, by the formula, its diameter is—

$$d = \frac{240,000 \times 1860}{206,265} = 2164 \text{ miles.}$$

DENSITY OF THE EARTH.

| Experiment. | Mean Density. | Observer. |
|---|---|---|
| Schehallien. . . . . | 5.01 | Maskelyne |
| Attraction of leaden ball | 5.48 | Cavendish |
| Ditto, repeated. . . . . | 5.66 | Baily |
| Harton coal-pit. . . . . | 6.56 | Airy |
| Probable value. . . . . | 5.53 | |

To Find the Period of a Planet.—The synodic period may be readily observed, and from it the actual time occupied by a planet in completing its revolution round the sun can be calculated. For example, the synodic period of Mercury is 115.9 days; this means that the earth and the planet being in a line with the sun at any time, the latter has progressed in its orbit so quickly as to complete an entire revolution and again overtake the earth during the period of 115.9 days. Now the earth moves $\frac{360°}{365.25} = 0.9856°$ in a day, and in the entire period $115.9 \times 0.9856° = 114.2°$. But the planet has moved $360° + 114.2° = 474.2°$ in the same time, hence the period of the planet is to that of the earth as 114.2° : 474.2°, that is, $\frac{114.2° \times 365.25}{474.2°} = 88$ days nearly.

Shooting Stars.—The names of the principal meteor swarms and the dates of their appearance are as follows:—

| Name. | Date. | Comet having same Orbit. |
|---|---|---|
| Andromedes . | 23 November | Biela's |
| Lyrids. . . . . | 20 April. . . . . | Comet I. 1861 |
| Leonids. . . . . | 15 November | Tempel's, 1866 |
| Perseids. . . . . | 11 August. . . | Comet III. 1863 |

The number of stars in the northern hemisphere in Argelander's catalogue is 324,000. The number of known variables is 111, and the suspected variables 381. Roughly, then, there is one variable in every 660 of the known stars. According to Duner, about 1 in 7 of the third type stars is variable.

To Find the Time of Sunrise and Sunset by means of the Terrestrial Globe.—The time of sunrise or sunset may be found for any day by elevating the north or south pole equal to the sun's declination north or south for any given day. The place being under the brass meridian, the hour circle should be set at XII., and then the place should be rotated first to the eastern horizon and then to the western and the times on the hour circle noted, the former being the time of rising, and the latter that of setting of the sun. Twice the time of setting of the sun gives the length of the day, and twice the time of rising gives the length of the night.

Example: 20th January, 1890, sun rose, 8.15; set, 3.45.

$2 \times 3.45 = 7\frac{1}{2}$ = length of day.

$2 \times 8.15 = 16\frac{1}{2}$ = length of night.

The months and days of the months are all marked on the ecliptic, so that the sun's place for any day is determined by finding the day on the ecliptic and noting the part of the sign of the zodiac corresponding to that day, and if the globe be turned till this part of the ecliptic comes to the meridian, the latter will indicate the declination of the sun.

*Note.*—The *Analemma* is a convenient projection of the ecliptic on which the sun's declination may be readily found, as it is noted for every day in the year.

Numerical Facts relating to the Sun.—Solar Parallax (equatorial horizontal), $8.80'' \pm 0.02''$. Mean distance of the sun from the earth, 92,885,000 miles; 149,480,000 kilometers. Variation of the distance of the sun from the earth between January and June, 3,100,000 miles; 4,950,000 kilometers. Linear value of 1″ on the sun's surface, 450.3 miles; 724.7 kilometers. Mean angular semi-diameter of the sun, 16′ 02.0″. Sun's linear diameter, 866,400 miles; 1,394,300 kilometers. (This may, perhaps, be *variable* to the extent of several hundred miles.) Ratio of the sun's diameter to the earth's, 109.3. Surface of the sun compared with the earth, 11,940. Volume, or cubic contents, of the sun compared with the earth, 1,305,000. Mass, or quantity of matter, of the sun compared with the earth, $330,000 \pm 3000$. Mean density of the sun compared with the earth, 0.253. Mean density of the sun compared with water, 1.406. Force of gravity on the sun's surface compared with that on the earth, 27.6. Distance a body would fall in one second, 444.4 feet; 135.5 meters. Inclination of the sun's axis to the ecliptic, 7° 15′. Longitude of its ascending node, 74°. Date when the sun is at the node, June 4, 5. Mean time of the sun's rotation (Carrington), 25.38 days. Time of rotation of the sun's equator, 25 days. Time of rotation at latitude 20°, 25.75 days. Time of rotation at latitude 30°, 26.5 days. Time of rotation at latitude 45°, 27.5 days. (These last four numbers are somewhat doubtful, the formulæ of various authorities giving results differing by several hours in some cases.) Linear velocity of the sun's rotation at his equator, 1.261 miles per second; 2.028 kilometers per second. Total quantity of sunlight, 1,575,000,000,000,000,000,000,000,000 candles. Intensity of the sunlight at the surface of the sun, 190,000 that of a candle flame; 5300 times that of metal in a Bessemer convertor; 146 times that of a calcium light; 3.4 times that of an electric arc. Brightness of a point on the sun's limb compared with that of a point near the center of the disk, 25 per cent. Heat received per minute from the sun upon a square meter, perpendicularly exposed to the solar radiation, at the upper surface of the earth's atmosphere (*the solar constant*), 25 calories. Heat radiation at the surface of the sun, per square meter per minute, 1,117,000 calories. Thickness of a shell of ice which would be melted from the surface of the sun per minute, 48¼ feet, or 14¾ meters. Mechanical equivalent of the solar radiation at the sun's surface, continuously acting, 109,000 horse power per square meter; or, 10,000 (nearly) per square foot. Effective temperature of the solar surface (according to Rossetti), about 10,000° C., or 18,000 F.

Nebular Hypothesis.—According to this theory, all the members of our solar system once existed in a state of highly heated gaseous or nebulous matter, which extended far beyond the orbit of our most remote planet, Neptune. This matter was supposed to have received a motion of rotation, and, as it cooled, became more and more condensed, the central portion leaving a ring of protuberant matter in the equatorial region, which, after becoming detached, would continue to revolve in the same direction as the parent mass, something after the fashion of Saturn's ring. This detached ring, it was presumed, would break up, and collecting into a globular mass retain its motion of rotation, and take up an additional motion of revolution around its primary. The detached planets formed in this way would, by a similar process, throw off their satellites, which, after long ages of cooling, have assumed their present state.

## SOME ELEMENTS OF THE PLANETARY SYSTEM.

| Name. | Mean Distance from Earth in Millions of Miles. | Sidereal Period of Revolution Round Sun | Time of Axial Rotation. | Real Diameter in Miles. | Volume ⊕ = 1. | Density ⊕ = 1. |
|---|---|---|---|---|---|---|
| | | D. | H. M. | | | |
| The Sun. ☉ | 92.9 | ..... | 607 48 | 866,400 | 1,300,000 | 0.25 |
| Mercury. ☿ | 56.9 | 88 | *24 5½ | 3,030 | 0.056 | 0.85 (?) |
| Venus. ♀ | 25.7 | 225 | *23 21⅓ | 7,700 | 0.920 | 0.89 |
| Earth. ⊕ | ..... | 365 | 23 56 | 7,918 | 1.000 | 1.00 |
| Mars. ♂ | 48.6 | 687 | 24 37½ | 4,230 | 0.152 | 0.71 |
| Jupiter. ♃ | 390.4 | 4,333 | 9 55⅓ | 86,500 | 1,309 | 0.24 |
| Saturn. ♄ | 793.2 | 10,759 | 10 14½ | 73,000 | 760 | 0.13 |
| Uranus. ♅ | 1,689.0 | 30,687 | 9 30 (?) | 31,900 | 59 | 0.22 |
| Neptune ♆ | 2,698.8 | 60,181 | ..... | 34,800 | 85 | 0.20 |

## THE SOLAR SYSTEM.

| | Mean distance from sun in miles. | Mean diameter in miles. | Satellites. |
|---|---|---|---|
| Sun | ..... | 860,000 | ..... |
| Mercury | 35,750,000 | 2,992 | 0 |
| Venus | 66,750,000 | 7,660 | 0 |
| Earth | 92,333,333 | 7,918 | 1 |
| Mars | 141,000,000 | 4,211 | 2 |
| Jupiter | 480,000,000 | 86,000 | 7 |
| Saturn | 881,000,000 | 70,500 | 9 |
| Uranus | 1,771,000,000 | 31,700 | 4 |
| Neptune | 2,775,000,000 | 34,500 | 1 |

## GREEK ALPHABET.

The different stars of the several constellations are usually indicated by the letters of the Greek alphabet. For convenience of reference, the alphabet is here given.

| | | | |
|---|---|---|---|
| A α Alpha. | H η Eta. | N ν Nu. | T τ Tau. |
| B β Beta. | Θ θ Theta. | Ξ ξ Xi. | Υ υ Upsilon. |
| Γ γ Gamma. | I ι Iota. | O ο Omicron. | Φ φ Phi. |
| Δ δ Delta. | K κ Kappa. | Π π Pi. | X χ Chi. |
| E ε Epsilon. | Λ λ Lambda | P ρ Rho. | Ψ ψ Psi. |
| Z ζ Zeta. | M μ Mu. | Σ ς Sigma. | Ω ω Omega. |

## NAMES OF THE PRINCIPAL STARS.

The following table exhibits the names of all the Stars of the First Three Magnitudes to which Astronomers have given names, at least all those whose names are in common use·

| | |
|---|---|
| α Andromedæ—Andromeda. | Alpheratz. |
| β " | Mirach Mizar. |
| γ " | Almach. |
| α Aquarii—Water Bearer. | Sadalmelik. |
| β " | Sadalsund. |
| δ " | Skat. |
| α Aquilæ—Eagle. | Altair. |
| β " | Alshain. |
| γ " | Tarazed. |
| α Arietis—Ram. | Hamal. |
| β " | Sheratan. |
| γ " | Mesartim. |
| α Aurigæ—Charioteer. | Capella. |
| β " | Menkalinan. |
| α Boötis—Herdsman. | Arcturus. |
| β " | Nekkar. |
| ε " | Izar, Mizar, Mirach. |
| η " | Muphrid. |
| α Canis Majoris—Great Dog. | Sirius. |
| β " " | Mirzam. |
| ε " " | Adara. |
| α Canis Minoris—Little Dog. | Procyon. |
| β " " | Gomeisa. |
| α Canum Venaticorum — Hunting Dogs. | Cor Caroli. |
| $\alpha^2$ Capricorni—Sea Goat. | Secunda Giedi. |
| δ " | Deneb Algiedi. |
| α Cassiopeiæ—Cassiopeia. | Schedar. |
| β " | Chaph. |
| α Cephei—Cepheus. | Alderamin. |
| β " | Alphirk. |
| γ " | Errai. |
| α Ceti—Whale. | Menkar. |
| β " | Diphda. |
| ζ " | Baten Kaitos |
| o " | Mira. |
| α Columbæ—Dove. | Phact. |
| α Coronæ Borealis—Crown. | Alphecca. |
| α Corvi—Crow. | Alchiba. |
| δ " | Algores. |
| α Crateris—Cup. | Alkes. |
| α Cygni—Swan. | Arided, Deneb Adige. |

* The periods of rotation of Mercury and Venus are possibly equal to their periods of revolution.

N.B.—The numbers in the third column refer to the mean distances at inferior conjunction for the inferior planets at opposition for the superior planets.

—*Knowledge Diary and Scientific Handbook.*

## NAMES OF THE PRINCIPAL STARS.—Continued.

| | | |
|---|---|---|
| β | Cygni—Swan | Albireo. |
| α | Draconis—Dragon | Thuban. |
| β | " | Alwaid. |
| γ | " | Etanin. |
| β | Eridani—River Eridanus. | Cursa. |
| γ | " | Zaurac. |
| α | Geminorum—Twins. | Castor. |
| β | " | Pollux. |
| γ | " | Alhena. |
| δ | " | Wesat. |
| ε | " | Mebsuta. |
| α | Herculis—Hercules. | Ras Algethi. |
| β | " | Korneforos. |
| α | Hydræ—Sea Serpent. | Al Fard, Cor Hydræ. |
| α | Leonis—Lion. | Regulus, Cor Leonis. |
| β | " | Deneb Aleet, Denedola, Deneb. |
| γ | " | Algeiba. |
| δ | " | Zosma. |
| α | Leporis—Wolf | Arneb. |
| α | Libræ—Scales. | Zuben el Genubi. |
| β | " | Zuben el Chamali. |
| γ | " | Zuben Hakrabi. |
| α | Lyræ—Lyre | Vega. |
| β | " | Sheliak. |
| γ | " | Sulaphat. |
| α | Ophiuchi—Serpent Bearer. | Ras Alhague. |
| β | " | Cebalrai. |
| α | Orionis—Orion | Betelgeux. |
| β | " | Rigel. |
| γ | " | Bellatrix. |
| δ | Orionis—Orion | Mintaka. |
| ε | " | Alnilam. |
| α | Pegasi—Pegasus. | Markab. |
| β | " | Scheat. |
| γ | " | Algenib. |
| ε | " | Enif. |
| ζ | " | Homan. |
| α | Persei—Perseus. | Mirfak. |
| β | " | Algol. |
| α | Piscis Australis—Southern Fish. | Fomalhaut. |
| ε | Sagittarii—Archer. | Kaus Australis. |
| α | Scorpionis—Scorpion. | Antares, Cor Scorpionis. |
| α | Serpentis—Serpent | Unukalhai. |
| α | Tauri—Bull. | Aldebaran. |
| β | " | Nath. |
| η | " | Alcyone (Pleiad). |
| α | Ursæ Majoris—Great Bear. | Dubhe. |
| β | " " | Merak. |
| γ | " " | Phecda. |
| ε | " " | Alioth. |
| ζ | " " | Mizar. |
| η | " " | Alkaid, Benetnasch. |
| ι | " " | Talitha. |
| α | Ursæ Minoris—Little Bear. | Polaris. |
| β | " " | Kochab. |
| α | Virginis—Virgin. | Spica Azimech, Spica. |
| β | " | Zavijava. |
| ε | " | Vindemiatrix |

## MAGNITUDES AND DISTANCES OF SOME OF THE STARS.

### POLARIS (ALPHA URSÆ MINORIS), THE NORTH STAR.

The parallax is $0''.075 \pm 0''.015$, according to Pritchard (1888). This parallax represents 2,318,000 times the distance of the Earth from the Sun, or, in other words, Polaris is distant 210,000,000,000,000 of miles. Estimating the velocity of light as 187,500 miles per second, the light from Polaris would take thirty-six years to reach the Earth. An express train traveling a mile a minute would have to run without stopping for 479,000,000 years in order to traverse this distance.

### ARCTURUS.

The parallax, as determined by Elkin in 1888, is $0''.018 \pm 0''.022$, and by Peters, in 1842–43, as $0''.127 \pm 0''.073$. The average $0''.094$ would make the distance of Arcturus from us to be 2,194,100 times the distance from the Earth to the Sun, or 200,000,000,000,000 of miles; and taking the velocity of light as 187,500 miles, it would require thirty-four years and six months for the light to reach us.

### VEGA.

This was the polar star of our Earth 14,000 years ago, and will again be the polar star in about 12,000 years. The parallax of Vega, which is $0''.15$, represents 1,375,000 times the distance of the Earth from the Sun, or 12,000,000,000,000 of miles. It takes twenty years and eight months for the light from Vega to reach us, estimating the velocity of light as 187,500 miles a second.

### ALTAIR.

The parallax, according to Elkin (1887), is $0''.199 \pm 0''.047$. Taking the average between the parallax of Struve, $0''.181 \pm 0''.094$, and that of Elkin as $0''.19$, the distance would be 1,086,000 times the distance of the Earth from the Sun, or 100,000,000,000,000 miles. It would require a little over seventeen years for the light of this star to reach us.

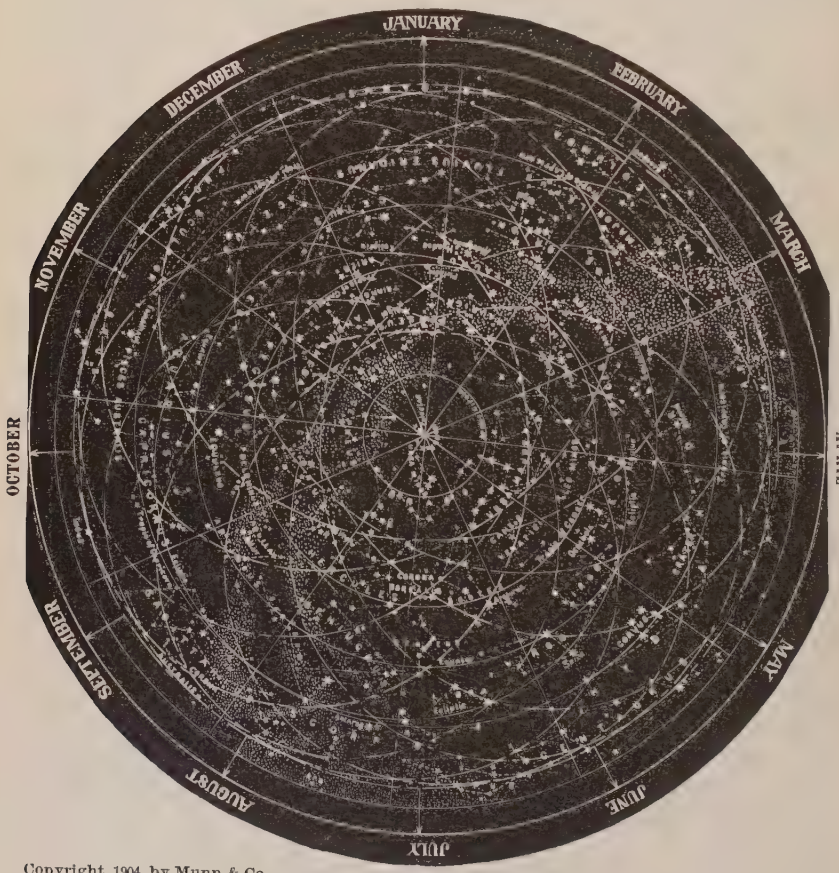
### SIRIUS, THE DOG STAR.

The parallax is $0''.266 \pm 0''.047$, according to Elkin (1888). Taking the average parallax of several observers as $0''.33$, it would represent 625,000 times the distance of the Earth from the Sun, or 58,000,000,000,000 of miles. The light of this star would require nine years and ten months to reach us. It is supposed the diameter of Sirius is about twenty times that of the Sun, and the volume of Sirius is possibly 7,000 times greater than our Sun.

## DIRECTIONS FOR USING THE STAR MAP.

Traced in dot and dash lines on the accompanying star map are a series of ellipses. From the points where these ellipses come nearest to the edge of the map, arrows project radially to the names of the months which are printed around the map. Each ellipse marks the extent of the heavens visible at nine o'clock p.m. of the first day of that month toward which its arrow points. To avoid confusion, the best plan is to cut in a piece of stiff paper an oval opening of the exact size of one of the ellipses, and to place this over the map, so as to expose to view only that portion of the map which represents the visible heavens at the

time of the observation. The map should be held with the arrow pointing toward the South, then contrary to custom in geographical maps the East will lie on the left-hand side and the West on the right-hand side. This is due to the fact that the heavens are viewed looking upward, whereas the map is viewed looking downward. In locating stars and constellations it is best to hold the map overhead, when the actual points of the compass and those marked on the map will bear the true relation to each other. Now, suppose the night be the first of December and the hour nine p.m.; cover up the entire map except that included within the ellipse whose arrow points to December. Then when the map is held overhead with the arrow pointing south it will be possible to pick out the stars visible at that hour and date. As time passes the ellipse must be slowly moved eastward around the Pole Star as a center at the rate of nearly 15 degrees per hour, so that two hours later, that is at 11 p.m., the visible heavens would correspond with that portion enclosed by the ellipse marked for the first of January. Owing to the fact that this eastward movement is not exactly 15 degrees per hour, the ellipse for the second day of December will

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## STAR MAP OF THE HEAVENS.

Stars of the first magnitude are indicated by an eight-point star, those of the second magnitude by a six-point star, third magnitude stars by five-point stars, fourth magnitude stars by four-point stars, and fifth magnitude stars by dots.

fall about one degree to the east of the position on the first of December at nine o'clock, so that at the end of thirty days it would move into coincidence with the ellipse traced for January 1st.

The following descriptions of the heavens apply to the stars visible at nine o'clock on the first days of the months, but it will be evident that the same description would apply for the stars visible at eight o'clock on the fifteenth of that same month, or for ten o'clock on the 15th and 11 o'clock on the first of the preceding month.

JANUARY.—The Great Bear, *Ursa Major*, is now rising well above the horizon, in the northeast, the Pointers about midway between north and northeast. The Dragon, *Draco*, lies due north, curving round under the Little Bear, its head close to the horizon. Low down in the northwest is a part of the Swan, *Cygnus*. Higher up we see King *Cepheus*, his wife, *Cassiopeia*, and their daughter, *Andromeda*, the Seated Lady and Chained Lady respectively, with the Rescuer, *Perseus*, nearly overhead. The Winged Horse is setting, his head close by the western horizon, and near the Jar of the Water Bearer, *Aquarius*. In the southwest is the Whale, and close by the constellation *Pisces*, or the Fishes; above them the Ram, *Aries*, between which and Andromeda the Triangle can be seen. In the south the River, *Eridanus*, makes now its best show. Its leading brilliant, *Achernar*, is, however, never seen in the United States. In the southwest the Great Dog with the splendid Sirius ("which brightliest shines when laved of ocean's wave") shows resplendently. Above is Orion, now standing upright, treading on the Hare, *Lepus*, and facing the Bull, *Taurus*, now at its highest. The Dove, *Columba*, below the Hare is a modern and not very interesting constellation. The Little Dog, *Canis Minor*, is on the east of Orion. In the east the Sea Serpent, *Hydra*, is rising, and due east a little higher we find *Cancer*, the Crab; above are the Twins, *Gemini*, and above them the Charioteer, *Auriga*, with the bright Capella, nearly overhead. The Lion is rising in the northeast, his heart star, Regulus, being low down a little north of east.

FEBRUARY.—The Great Bear, *Ursa Major*, with its Dipper and Pointers, occupies the northeasterly midheaven. The Dragon, *Draco*, curves round the Little Bear toward the Pointers. In the northwest, fairly high up, we find *Cassiopeia*, the Seated Lady, and on her right, lower down, the inconspicuous constellation *Cepheus*. *Andromeda*, the Chained Lady, is on Cassiopeia's left. Above Andromeda is *Perseus*, the Rescuing Knight and above him the Charioteer, *Auriga*, nearly overhead. On the left of Andromeda is *Aries*, the Ram, the small constellation the Triangle lying between them. Toward the southwest, the Whale, *Cetus*, is beginning to set. The River, *Eridanus*, occupies the lower part of the southwesterly sky, and extends also to the midheavens in that direction. The Dove, *Columba*, lies toward the south, and is at its best, which is not saying much. Above is the Hare, *Lepus*, on which *Orion* treads. The giant now presents his noblest aspect—prince of all the constellations, as he is. He faces the Bull, *Taurus*, known by the Pleiades and the bright Aldebaran. Close by the poor Hare, on the left, leaps *Canis Major*, the Greater Dog, with the bright Sirius, which "bickers into green and emerald." The stern of the Star-Ship, *Argo*, is nearing the south. Very high in the southeast we find the Twins, *Gemini*, with the twin stars, Castor and Pollux, and below them the Little Dog, *Canis Minor*. The Sea Serpent, *Hydra*, is rearing its tall neck above the eastern horizon (by south), as if aiming either for the Little Dog or for the Crab, *Cancer*, now high up in the east, with its pretty Beehive cluster showing well in clear weather. The Lion, *Leo*, is due east, the Sickle being easily recognized.

MARCH.—The Great Bear, *Ursa Major*, with its Dipper and Pointers, is now high up in the northeastern sky. The Dragon, *Draco*, extends from between the Bears to the horizon, east of north, where its head with its two bright eyes can be seen. *Cepheus* is low down, somewhat to the west of north; his Queen, *Cassiopeia*, the Seated Lady, beside him. *Andromeda*, the Chained Lady, is in the northwest, low down—in fact, partly set; the Triangle, and next the Ram, *Aries*, beside her, toward the west. Above them is *Perseus*, the Rescuing Knight; and above him, somewhat to the west, the Charioteer, *Auriga*. The Bull, *Taurus*, with the Pleiades and the bright Aldebaran, is in the midheaven, due west; *Gemini*, the Twins, higher, and toward the southwest. Orion, below them, is already slanting toward his grave, low down in the west; beneath him the Hare, and in the southwest a part of the River, *Eridanus*. Due south is a part of the Star Ship, *Argo* beside which, low down, is the foolish Dove, *Columba*, while above leaps the Great Dog, *Canis Major*, with the splendid Sirius, chief of all the stars in the sky, marking his mouth. High up, a little west of north, is the Little Dog, *Canis Minor*, and higher, a little east of north, the Crab, *Cancer*, the dark constellation, as it was called of old, with the pretty cluster, *Præsepe*, or the Beehive. The Sea Serpent, *Hydra*, is rearing his long neck high above the horizon, bearing, absurdly enough, on his back Noah's Cup, *Crater*, and Noah's Raven, or Crow, *Corvus*. Nearly due east, the Virgin, *Virgo*, has risen. The Lion, *Leo*, occupies the midspace above. East of the Great Bear lies Hevelius's foolish constellation, the Hunting Dogs, *Canes Venatici*. Lastly, in the northeast, the Herdsman, *Bootes*, with the orange-yellow brilliant Arcturus, is rising, though at present, paradoxical as it may seem, he lies on his back.

APRIL.—The Great Bear, *Ursa Major*, is now nearing the point overhead, the Pointers, aiming almost directly downward toward the Pole Star. *Cepheus* lies north, low down; *Cassiopeia* on his left. Perseus is nearing the horizon, the Charioteer, *Auriga*, on his left, but higher. Setting toward the west we see the Bull, *Taurus*, with the Pleiades and the ruddy Aldebaran. *Orion* is almost prone in his descent toward his western grave. The Twins, *Gemini*, are due west, in the midheavens; the Little Dog, *Canis Minor*, beside them on their left; the Crab, *Cancer*, above; the Greater Dog, *Canis Major* below, chasing the Hare, *Lepus*, below the horizon. Just behind the Dog the poop of the Great Ship, *Argo*, is also setting. The Sea Serpent, *Hydra*, now shows his full length, rearing

his head high in the south. Observe the darkness of the region around his heart. *Alfard*, the Solitary One. The Cup, *Crater*, and Crow, *Corvus*, stand on his back. The Sickle in the Lion, *Leo*, now stands with handle upright, due south. Below the tail stars of the Lion we see the Virgin, *Virgo*. The Herdsman, *Bootes*, still on his back pursues in that striking and effective position the Great Bear. Below the shoulder stars of the Herdsman we see the Crown, *Corona Borealis*, near which, on the right, low down and due east, the head of the Serpent, *Serpens*, is rising.

MAY.—The Great Bear, *Ursa Major*, is now at its highest and nearly overhead, the Pointers aiming downward from high up, slightly west of due north. Below the Little Bear we find *Cepheus* low down to the east of north, and *Cassiopeia* low down to the west of north. *Perseus*, the Rescuer, is setting in the northwest. The Charioteer, *Auriga*, with the bright Capella, is nearing the northwestern horizon, followed by the Twins, *Gemini*, in the west. Further west and higher we find the Crab, *Cancer*, below which is the Little Dog, *Canis Minor*. The southwestern sky is very barren of bright stars, *Alfard*, the heart of the Sea Serpent, *Hydra*, shining alone in a great blank space. Above the Sea Serpent's head we see the Sickle in the Lion, *Leo*, himself stretching his tail to due south, very high up. In the south, lower down, we find the Crow, *Corvus*, and the Cup, *Crater*, on the Serpent's back; the Virgin, *Virgo*, extending in the midheavens from southeast to south, between the Lion's tail and the Crow. In the same direction, but low down, we find the head and body of the Centaur, *Centaurus*, supposed to have typified the patriarchal Noah. In the southeast the Scorpion is just beginning to appear, and between the head of *Scorpio* and the Virgin's robes we see the stars of the Scales, *Libra*. Due east, low down, is the Serpent Bearer, *Ophiuchus*, on his back—'tis the customary attitude of heavenly bodies when rising. The Serpent, *Serpens*, held by him is seen curving upward toward the Crown, *Corona Borealis*. The Serpent's head is due west, and above it we see the bright Arcturus, chief brilliant of the Herdsman, *Bootes*. In the northeast is *Hercules*, his head close to the head of the Serpent Bearer. Beneath his feet is the Lyre, *Lyra*, with the brilliant Vega; and the Swan, *Cygnus*, has already half risen above the northeastern horizon. Lastly, the Dragon, *Draco*, curves from between the Pointers and the Pole, round the Guardians, toward Cepheus, and then retorts its head with gleaming eyes, $\beta$ and $\gamma$, toward the heel of Hercules.

JUNE.—The Great Bear, *Ursa Major*, occupies all the upper sky from west to north, except a small space occupied by the Hunting Dogs, *Canes Venatici*. Due south, low down, lies *Cassiopeia*, while above, somewhat toward the east, we find the inconspicuous constellation *Cepheus*. Low down in the northwest lie the Charioteer, *Auriga*, and the head stars of the Twins, *Gemini*, farther west. The Crab, *Cancer*, is nearly due west, the Sea Serpent, *Hydra*, holding his head almost exactly to the west point. Above is the Sickle in the Lion, its blade curved downward, and the tail of the Lion, *Leo*, lies above, toward the south of west. On the Serpent's back we find the Cup, *Crater*, and the Crow, *Corvus*, in the southwest and to the south of southwest respectively. Above these constellations the Virgin, *Virgo*, occupies the midheavens. Above the Virgin we see the Herdsman, *Bootes*, his head and shoulders nearly overhead. Low down in the south is the Centaur, *Centaurus*, bearing on his spear the Wolf, *Lupus*, as an offering for the Altar, *Ara*, which, however, is invisible in these latitudes. Above the Wolf we see the Scales, *Libra*, while the Scorpion, *Scorpio*, one of the few constellations which can at once be recognized by its shape, is rising balefully in the southeast. Te Serpent Bearer, *Ophiuchus*, bears the Serpent, *Serpens*, in the midheavens toward the southeast, the Crown, *Corona Borealis*, being high up in the east, close by the Serpent's head. Low down in the east is the Eagle, *Aquila*, with the fine steel blue star Altair, the Swan on the left about northeast, and above it the Lyre, *Lyra*, with the still more brilliant steel blue star *Vega*. Hercules occupies the space between the Lyre on the one side and the Crown and the Serpent's head on the other. He is high up, due east.

JULY.—The Great Bear, *Ursa Major*, is in the midheavens toward the northwest, the Pointers not far from the horizontal position. The Dragon, *Draco*, curls over the Little Bear, curving upward on the east, to where its head, high up in the northeast, is marked by the gleaming eyes, $\beta$ and $\gamma$. Low down in the West the Lion, *Leo*, is setting. The point of the "Sickle in the Lion" is turned to the horizon; the handle is nearly horizonatal. The Crow, *Corvus*, is low down in the southwest, the Cup, *Crater*, beside it, partly set, on the right. Above is *Virgo*, the Virgin. Still higher in the southwest—in fact, with head close to the point overhead—is the Herdsman, *Bootes*, the Crown, *Corona Borealis*, near his southern shoulder marking what was once the Herdsman's uplifted arm. Low down between the south and southwest we find the head and shoulders of the Centaur, *Centaurus*, who holds the Wolf, *Lupus*, due south. In the midsky, toward the southeast, we find the Serpent Holder, *Ophiuchus*. Below the Serpent Holder we find the Scorpion, *Scorpio*, now fully risen, and showing truly scorpionic form. Beside the Scorpion is the Archer, *Sagittarius*, low down in the southeast. Above, near the point overhead, is the kneeling *Hercules*. Due east, we see part of the Winged Horse, *Pegasus:* above that, the little Dolphin, *Delphinus:* and higher, the Swan, *Cygnus*, and the Lyre, *Lyra*, with the beautiful bluish-white star Vega. Lastly, low down, between north and northeast, we find the Seated Lady, *Cassiopeia:* and above, somewhat eastwardly, the inconspicuous constellation *Cepheus*, Cassiopeia's royal husband.

AUGUST.—The Great Bear, *Ursa Major*, is now in the northwest, his paws near the horizon. The Dragon, *Draco*, curves round from between the Pointers and the Pole, above the Little Bear toward the east, then upward to near the point overhead, its head, with the bright stars $\beta$ and $\gamma$, being highest. The Herdsman, *Bootes*, occupies the midheavens in the west, the Crown, *Corona Borealis*, higher up, and due west Hercules, between the Crown and the point overhead. Low down, extending from the west to near the southwest, we find the Virgin, *Virgo*, the bright

Spica near its setting place. In the southeast are the Scales, *Libra*, and, farther to the left, extending from the Scales to low down near the south, we find the Scorpion, *Scorpio*, one of the finest of the constellations, Antares, the rival of Mars (as the name means), marking its heart. Above the Scorpion and the Scales are the Serpent Holder, *Serpentarius* or *Ophiuchus*, and the Serpent, *Serpens*, extending right across him to near the Crown, after which the Serpent seems reaching. A little east of due south, low down, we find the Archer, *Sagittarius:* in the southeast, low down, the Sea Goat, *Capricornus:* and farther east, and lower down, the Water Bearer, *Aquarius*. Above the Sea Goat is the Eagle, *Aquila*, with the bright bluish-white star Altair; on its left, the pretty little Dolphin, *Delphinus*, and above the Dolphin, nearly overhead, the Lyre, *Lyra*, with the bluish-white star Vega (even brighter than Altair) nearly overhead. Below the Lyre we see the Swan, *Cygnus*, due east; and below the Swan the Winged Horse, *Pegasus*, upside down, as usual. In the northeast, *Andromeda*, the Chained Lady, is rising. Between the north and northeast is *Cassiopeia*, the Seated Lady, and above her, her husband, King Cepheus.

September.—The Great Bear, *Ursa Major*, is low down, between northwest and north, the Pointers directed slantingly upward toward the Pole. Between the Great Bear and the Little Bear run the stars of the Dragon, *Draco*, round the Little Bear toward the north, thence toward the northwest, where we see the head of the Dragon high up, his two bright eyes, directed toward *Hercules*, which occupies the western mid-heaven. Above Hercules is the Lyre, *Lyra*, with the bright steel-blue star Vega high up toward the point overhead. Right overhead is the Swan, *Cygnus*. Near the west stands the Herdsman, rather slanting forward, however, with the Crown, *Corona Borealis*, on his left, almost due west. The long winding Serpent, *Serpens*, runs from near the Crown, where we see its head, due west to farther south than southwest, high up, on the western side of the Serpent Holder, *Serpentarius* or *Ophiuchus*, now standing upright in the southwest. Low down creeps the Scorpion, *Scorpio*, its heart Antares, rival of Mars, in the southwest, the end of its tail between south and southwest. Above, and south of the Scorpion's tail, we see the Archer, *Sagittarius*. Due south and high up is the Eagle, *Aquila*, the bright steel-blue Altair marking its body. On the left, or east, of the Eagle lies the neat little Dolphin, *Delphinus*. Midway between the Dolphin and the horizon is the tip of the tail of the Sea Goat, *Capricornus*, whose head lies nearly due south. On the southern horizon is the head of the Indian, *Indus;* and low down in the southeast lies Fomalhaut, the chief brilliant of the Southern Fish, *Piscis Australis*. Above lies the Water Bearer, *Aquarius*, in the southwestern midheaven. Due east, fairly high, is the "Square of Pegasus," the head of the Winged Horse, *Pegasus*, lying close by the Water Pitcher of Aquarius. The Fishes, *Pisces*, are low down in the east. On the left of Pisces we see the Ram, *Aries*, low down; above it, the Triangle; and above that, the Chained Lady, *Andromeda*. Low down in the northeast is the Rescuing Knight, *Perseus;* above whom is *Cassiopeia;* and on her left, higher up, the inconspicuous constellation *Cepheus*.

October.—Low down between north and northwest we find the seven stars of the Dipper, the Pointers on the right nearly due north. They direct us to the Pole Star. Between the Pointers and the Pole Star we find the tip of the Dragon's tail, and sweep round the Little Bear with the Dragon's long train of third magnitude stars, till we come, after a bend, to the Dragon's head, with the two bright eyes, $\beta$ and $\gamma$. These two stars are almost exactly midway between the horizon and the point overhead, and nearly northwest. King Cepheus—not a very conspicuous constellation—lies between the point overhead and the Little Bear. Low down in the northwest we find the head of the Herdsman, *Bootes*. The Crown, *Corona Borealis*, which no one can mistake, lies on his left, and close by is the setting head of the Serpent. Above these three groups we see Hercules—the Kneeler. Above the head of Hercules we find the Lyre, with the bright star Vega; and above that the Swan. Passing southward, we see the Serpent Holder, *Serpentarius* or *Ophiuchus*, beyond whom lies the Serpent's tail, a most inconvenient arrangement, as the Serpent is divided into two parts. Almost exactly southeast, and low down, are the stars of the Archer, *Sagittarius;* while above, in the mid-sky, we see the Eagle, *Aquila*, with the bright Altair. Note the neat little constellation, the Dolphin, *Delphinus*, close by. Due south is the Crane, *Grus;* above it, the Southern Fish, with the bright star Fomalhaut; above that, the Sea Goat, *Capricornus*, and on the left of this the Water Bearer, *Aquarius;*. Toward the east, high up, is the Winged Horse, *Pegasus;* he is upside down just now. Below lies the Whale, *Cetus*, or, rather, the Sea Monster. The Fishes, *Pisces*, may be seen between the Whale and Pegasus. Few constellations have suffered more than Pisces by the breaking up of star groups. The fishes themselves are now lost in Andromeda and Pegasus. Note how, on the left of Pisces the Ram, *Aries*, "bears aloft" Andromeda, the Chained Lady, as Milton set Aries doing long since. The Triangle serves only as a saddle. Between Andromeda and her father, Cepheus, we find her mother, Cassiopeia, or, rather, Cassiopeia's Chair. Perseus, the Rescuer, lies below.

November.—The Dipper lies low, the Pointers a little east of north. Between the Pointers and Pole Star lies the tip of the Dragon's tail. Low down in the northwest, Hercules is setting. Above is the Lyre, with the bright steel-blue Vega; and above that the stars of the Swan, *Cygnus*, which has sometimes been called the Northern Cross. Nearly due west we find the Eagle, *Aquila*. Above the Eagle is the pretty little constellation the Dolphin, *Delphinus*. In the southwest, rather low, is the Sea Goat, *Capricornus;* above, and to the south of him, the Water Bearer, *Aquarius*. The head of the Winged Horse, *Pegasus*, now upside down (in fact, he is seldom otherwise), is just above this group. Much attention need not be directed to the lowly *Phoenix*, low in the southern horizon. The River, *Eridanus*, is coming well into view; and the great Sea Monster, *Cetus*, now shows finely. The Fishes, *Pisces*,

are above; the Ram, *Aries*, above them, and eastward, lying toward the southeast; then the Triangle, *Trianqula* (or the Triangles, according to modern maps), and the Chained Lady, *Andromeda*, too nearly overhead to be very pleasantly observed. The grand giant, *Orion*, is rising in the east; above him, the Bull, *Taurus*, with the Pleiades. Low down in the northeast the Twins, *Gemini*, are rising; above is the Charioteer, *Auriga*, and above him the Rescuing Knight, *Perseus*, "of fair-haired Danaë born."

DECEMBER.—The Great Bear, *Ursa Major*, is beginning to rise above the northeast by north horizon. The end of the Dipper's handle is hidden. The stars of the Dragon wind round below the Little Bear toward the west, the head of the Dragon with the gleaming eyes ("oblique retorted that askant cast gleaming fire") being low down, a little north of northwest. Above is King Cepheus, and above him his queen, the Seated Lady, *Cassiopeia*, their daughter, the Chained Lady, *Andromeda*, being nearly overhead. Low down in the northwest we see the Lyre, *Lyra*, with the bright Vega, and close by toward the west the Swan, *Cygnus*, or Northern Cross. The Eagle is setting in the west, and the little Dolphin nears the western horizon. Toward the southwest by west we see the Water Bearer, *Aquarius*, with his Pitcher, close by which is the head of the Winged Horse, *Pegasus*. In the south, low down, is the absurd Phœnix; above, the Sea Monster, or Whale, *Cetus;* above him, the Fishes, *Pisces;* above them, the Ram, *Aries;* while nearly overhead lies the Triangle. The River *Eridanus*, occupies the southeasterly sky, the Dove and Great Dog, *Columba* and *Canis Major*, rising in the southeast. The glorious Orion has now come well into position, though not yet so upright as we could wish, a knightly hunter to be. He treads on the Hare, *Lepus*, and faces the Bull, *Taurus*, above. Due east we find the Crab, *Cancer*, and Little Dog, *Canis Minor*, low down; the Twins, *Gemini*, higher; above them the Charioteer, *Auriga*, with the bright *Capella*, and *Perseus*, the Rescuer, nearing the point overhead.—*R. A. Procter's Star Maps*. Copyright, 1903, by Munn & Co.

## THE LARGE REFRACTORS OF THE WORLD.

| Institution. | Aperture in Inches. | Focal Length in Feet. | Date of Erection. |
|---|---|---|---|
| Yerkes Observatory, Wisconsin, U. S. A. | 40.0 | 62.0 | 1897 |
| Lick Observatory, California, U. S. A. | 36.0 | 57.8 | 1888 |
| Lick Observatory, California, U. S. A. | 33.0 | 49.2 | ..... |
| National Observatory, Meudon. | 32.5 | 53.0 | 1891 |
| Astrophysical Observatory, Potsdam. | 31.1 | 39.4 | ..... |
| Bischoffsheim Observatory, Nice. | 30.3 | 52.6 | 1889 |
| Imperial Observatory, Poulkova. | 30.0 | 42.0 | 1882 |
| National Observatory, Paris. | 28.9 | ..... | ..... |
| Royal Observatory, Greenwich. | 28.0 | 28.0 | 1894 |
| Imperial Observatory, Vienna. | 27.0 | 34.0 | 1894 |
| Royal Observatory, Greenwich. | 26.0 | 26.0 | 1897 |
| Naval Observatory, Washington. | 26.0 | 32.5 | 1871 |
| Leander McCormick Observatory, Virginia, U. S. A. | 26.0 | 32.5 | 1874 |
| Cambridge University Observatory. | 25.0 | ..... | 1868 |
| National University, Meudon. | 24.4 | 52.2 | 1891 |
| Harvard College, Cambridge, U. S. A. | 24.0 | 11.3 | 1894 |
| Royal Observatory, Cape of Good Hope. | 24.0 | 22.6 | 1897 |
| Lowell Observatory, Mexico. | 24.0 | 31.0 | 1895 |
| National Observatory, Paris. | 23.6 | 59.0 | 1889 |
| Halstead Observatory, Princeton, U. S. A. | 23.0 | 32.0 | 1881 |
| Etna. | 21.8 | ..... | ..... |
| Buckingham Observatory. | 21.2 | ..... | ..... |
| M. Porro, Private Observatory, Italy. | 20.5 | ..... | ..... |
| Chamberlin Observatory, Colorado, U. S. A. | 20.0 | 28.0 | 1891 |
| Manila Observatory, Philippines. | 20.0 | ..... | 1892 |
| Astrophysical Observatory, Potsdam. | 19.7 | 41.2 | ..... |
| Imperial Observatory, Strassburg. | 19.1 | 23.0 | 1880 |
| Milan Observatory, Italy. | 19.1 | 23.0 | ..... |
| North-Western Observatory, Illinois, U. S. A. | 18.5 | 27.0 | 1863 |
| Dearborn Observatory. | 18.5 | ..... | ..... |
| National Observatory, La Plata. | 18.1 | 29.5 | 1890 |
| Lowell Observatory, Mexico. | 18.0 | 26.3 | 1894 |
| Flower Observatory, Philadelphia, U. S. A. | 18.0 | ..... | 1896 |
| Vander Zee Observatory. | 18.0 | ..... | ..... |
| Royal Observatory, Cape of Good Hope. | 18.0 | 22.6 | 1897 |

—Knowledge Diary and Scientific Handbook.

# PART IV.

## WEIGHTS AND MEASURES.

### LINEAR MEASURE.

| | | |
|---|---|---|
| 3 barleycorns, or | | |
| 12 lines, or | | 1 inch (in.) |
| 72 points, or | | |
| 1,000 mils (mi.) | | |
| 3 inches | = | 1 palm |
| 4 inches | = | 1 hand |
| 9 inches | = | 1 span |
| 12 inches | = | 1 foot (ft.) |
| 18 inches | = | 1 cubit |
| 3 feet | = | 1 yard (yd.) |
| 2½ feet | = | 1 military pace |
| 5 feet | = | 1 geometrical pace |
| 2 yards | = | 1 fathom |
| 5½ yards | = | 1 rod, pole, or perch |
| 66 feet, or | | 1 Gunter's chain |
| 4 rods | | |
| 40 poles, or | | 1 furlong (fur.) |
| 220 yards | | |
| 8 furlongs, or | | 1 mile |
| 1,760 yards, or | | |
| 5,280 feet | | |
| 3 miles | = | 1 league |

The hand is used to measure horses' height. The military pace is the length of the ordinary step of a man. One thousand geometrical paces were reckoned to a mile.

### LAND MEASURE (LINEAR).

| | | |
|---|---|---|
| 7.92 inches | = | 1 link |
| 100 links, or | | 1 chain (ch.) |
| 66 feet, or | | |
| 22 yards, or | | |
| 4 poles | | |
| 10 chains | = | 1 furlong (fur.) |
| 80 chains, or | | 1 mile |
| 8 furlongs | | |

### LAND MEASURE (SQUARE).

| | | |
|---|---|---|
| 144 sq. inches | = | 1 square foot (sq. ft.) |
| 9 square feet | = | 1 square yard (sq. yd.) |
| 30¼ sq. yards | = | 1 sq. pole, rod, or perch |
| 16 sq. poles | = | 1 square chain (sq. ch.) |
| 40 sq. poles, or | | 1 sq. rood |
| 1,210 sq. yards | | |
| 4 roods, or | | 1 acre * |
| 10 sq. chs., or | | |
| 160 sq. poles, or | | |
| 4,840 sq. yds., or | | |
| 43,560 sq. ft | | |
| 640 acres, or | | 1 sq. mile |
| 3,097,600 sq. yds | | |
| 30 acres | = | 1 yard of land |
| 100 acres | = | 1 hide of land |
| 40 hides | = | 1 barony |

### CUBIC MEASURE.

| | | |
|---|---|---|
| 1,728 cubic inches | = | 1 cubic foot |
| 27 cubic feet | = | 1 cubic or solid yard |

* The side of a square having an area of an acre is equal to 69.57 linear yards.

### GEOGRAPHICAL AND NAUTICAL MEASURE.

| | | |
|---|---|---|
| 6086.44 | feet, or | |
| 1000 | fathoms, or | = 1 nautical mile |
| 10 | cables, or | |
| 1.1528 | statute miles | |
| 1 | nautical mile per hour | = 1 knot |
| 60 | nautical miles, or | = 1 degree |
| 67.168 | statute miles | |
| 360 | degrees | = 1 circumference of the earth at the equator |
| 1 | league | = 3 nautic'l miles |
| 1 | cable's length | = 120 fathoms |

### DRY MEASURE, U. S.

| | | | Cu. In. |
|---|---|---|---|
| 2 pints | = 1 quart (qt.) | = | 67.20 |
| 4 quarts | = 1 gallon (gal.) | = | 268.80 |
| 2 gallons, or | 1 peck | = | 537.60 |
| 8 quarts | | | |
| 4 pecks | = 1 struck bushel | = | 2150.42 |

### LIQUID MEASURE, U. S.

| | | | Cu. In. |
|---|---|---|---|
| 4 gills | = 1 pint (O.) | = | 28.875 |
| 2 pints | = 1 quart (qt.) | = | 57.75 |
| 4 quarts | = 1 gallon (gal.) | = | 231. |
| 63 gallons | = 1 hogshead (hhd.) | | |
| 2 hogsheads | = 1 pipe or butt | | |
| 2 pipes | = 1 tun | | |

### APOTHECARIES' LIQUID MEASURE.

Apothecaries' or Wine Measure is used by pharmacists of this country. Its denominations are gallon, pint, fluid ounce, fluid drachm, and minim, as follows:

| Cong. | O. | F. Oz. | F. Dr. | Minims. |
|---|---|---|---|---|
| 1 = | 8 = | 128 = | 1,024 = | 61,440 |
| | 1 = | 16 = | 128 = | 7,680 |
| | | 1 = | 8 = | 480 |
| | | | 1 = | 60 |
| | | | | 1 |

The Imperial Standard Measure is used by British pharmacists. Its denominations and their relative value are:

| Gal. | Quarts. | Pints. | F. Oz. | F. Dr. | Minims. |
|---|---|---|---|---|---|
| 1 = | 4 = | 8 = | 160 = | 1,280 = | 76,800 |
| | 1 = | 2 = | 40 = | 320 = | 19,200 |
| | | 1 = | 20 = | 160 = | 9,600 |
| | | | 1 = | 8 = | 480 |
| | | | | 1 = | 60 |

The relative value of United States Apothecaries' and British Imperial Measures is as follows:

| U. S. Apothecaries' Measure. | | Imperial Measure. Pints. | F. Oz. | F. Dr. | Minims |
|---|---|---|---|---|---|
| 1 Gallon = | .83311 Gallon, or | 6 | 13 | 2 | 22.85 |
| 1 Pint = | .83311 Pint, or | | 16 | 5 | 17.86 |
| 1 Fl. Oz. = | 1.04139 Fl. Oz., or | | 1 | 0 | 19.86 |
| 1 Fl. Dr. = | 1.04139 Fl. Dr., or | | | 1 | 2.48 |
| 1 Minim = | 1.04139 Minim, or | | | | 1.04 |

OLD WINE AND SPIRIT MEASURE.

| | | Imperial Gals. |
|---|---|---|
| 4 gills or quarterns. | 1 pint | |
| 2 pints. | 1 quart | |
| 4 quarts (231 cu. in.) | 1 gallon | = .8333 |
| 10 gallons. | 1 anchor | = 8.333 |
| 18 gallons. | 1 bunlet | = 15 |
| 31½ gallons. | 1 barrel | = 26.25 |
| 42 gallons. | 1 tierce | = 35 |
| 63 gallons, or 2 barrels | 1 hogshead | = 52.5 |
| 84 gallons, or 1½ hogsheads | 1 puncheon | = 70 |
| 126 gallons, or 2 hogsheads or 1½ puncheons. | 1 pipe or butt | = 105 |
| 2 pipes or 3 puncheons | 1 tun | = 210 |

Apothecaries' Weight is the officinal standard of the United States Pharmacopœia. In buying and selling medicines not ordered by prescriptions avoirdupois weight is used.

| Lb. | Oz. | Dr. | Scr. | Gr. |
|---|---|---|---|---|
| 1 = | 12 = | 96 = | 288 = | 5760 |
| | 1 = | 8 = | 24 = | 480 |
| | | 1 = | 3 = | 60 |
| | | | 1 = | 20 |

Avoirdupois Weight.—Used for weighing all goods except those for which troy and apothecaries' weight are employed.

| Gross or Long Ton. | Cwt. | Qr. | Lb. | Oz. | Dr. |
|---|---|---|---|---|---|
| 1 = | 20 = | 80 = | 2,240 = | 35,840 = | 573,440 |
| | 1 = | 4 = | 112 = | 1,792 = | 28,672 |
| | | 1 = | 28 = | 448 = | 7,168 |
| | | | 1 = | 16 = | 256 |
| | | | | 1 = | 16 |

| Short or Net Ton. | Cwt. | Qr. | Lb. | Oz. | Dr. |
|---|---|---|---|---|---|
| 1 = | 20 = | 80 = | 2,000 = | 32,000 = | 512,000 |
| | 1 = | 4 = | 100 = | 1,600 = | 25,600 |
| | | 1 = | 25 = | 400 = | 6,400 |
| | | | 1 = | 16 = | 256 |
| | | | | 1 = | 16 |

The "short" ton of 2,000 lbs. is used commonly in the United States. The British or "long" ton, used to some extent in the United States, contains 2,240 lbs., corresponding to a cwt. of 112 and a quarter of 28 lbs.

Troy Weight.—Used by jewelers and at the mints, in the exchange of the precious metals.

| Lb. | Oz. | Dwt. | Gr. |
|---|---|---|---|
| 1 = | 12 = | 240 = | 5760 |
| | 1 = | 20 = | 480 |
| | | 1 = | 24 |

7000 troy grains = 1 lb. avoirdupois.
175 troy pounds = 144 lb. avoirdupois.
175 troy ounces = 192 oz. avoirdupois.
437½ troy grains = 1 oz. avoirdupois.
1 troy pound = .8228+ lb. avoirdupois.

The common standard of weight by which the relative values of these systems are compared is the grain, which for this purpose may be regarded as the unit of weight. The pound troy and that of apothecaries' weight have each five thousand seven hundred and sixty grains; the pound avoirdupois has seven thousand grains.

The relative proportions and values of these several systems are as follows:

| Troy. | Avoirdupois. Oz. | Dr. |
|---|---|---|
| 1 pound equals | 13 | 2.65 |
| 1 ounce equals | 1 | 1.55 |
| 1 dwt. equals | 0 | 0.877 |

| Troy. | —Apothecaries'.— Lb. | Oz. | Dr. | Scr. | Gr. |
|---|---|---|---|---|---|
| 1 pound equals | 1 | 0 | 0 | 0 | 0 |
| 1 ounce equals | 0 | 1 | 0 | 0 | 0 |
| 1 dwt. equals | 0 | 0 | 0 | 1 | 4 |
| 1 grain equals | 0 | 0 | 0 | 0 | 1 |

| Apothecaries'. | Avoirdupois. Oz. | Dr. |
|---|---|---|
| 1 pound equals | 13 | 2.65 |
| 1 ounce equals | 1 | 1.55 |
| 1 drachm equals | 0 | 2.19 |
| 1 scruple equals | 0 | 0.73 |

| Apothecaries'. | —Troy.— Lb. | Oz. | Dwt. | Gr. |
|---|---|---|---|---|
| 1 pound equals | 1 | 0 | 0 | 0 |
| 1 ounce equals | 0 | 1 | 0 | 0 |
| 1 drachm equals | 0 | 0 | 2 | 12 |
| 1 scruple equals | 0 | 0 | 0 | 20 |

| Avoirdupois. | —Troy.— Lb. | Oz. | Dwt. | Gr. |
|---|---|---|---|---|
| 1 long ton equals | 2722 | 2 | 13 | 8 |
| 1 cwt. equals | 136 | 1 | 6 | 16 |
| 1 quarter equals | 34 | 0 | 6 | 16 |
| 1 pound equals | 1 | 2 | 11 | 16 |
| 1 ounce equals | 0 | 18 | | 5½ |
| 1 drachm equals | 0 | 1 | | 31 1/32 |

| Avoirdupois. | —Troy.— Lb. | Oz. | Dwt. | Gr. |
|---|---|---|---|---|
| 1 short ton equals | 2430 | 6 | 13 | 8 |
| 1 cwt. equals | 121 | 6 | 6 | 16 |
| 1 quarter equals | 30 | 4 | 11 | 16 |

| Avoirdupois. | —Apothecaries'.— Lb. | Oz. | Dr. | Scr. | Gr. |
|---|---|---|---|---|---|
| 1 pound equals | 1 | 2 | 4 | 2 | 0 |
| 1 ounce equals | 0 | 0 | 7 | 0 | 17½ |
| 1 drachm equals | 0 | 0 | 0 | 1 | 7 1/32 |

DIAMOND MEASURE.

16 parts = 1 grain 0.8 troy grains.
4 grains = 1 carat = 3.2 troy grains.

HOUSEHOLD MEASURES.—Nothing is more vague and inaccurate than such expressions as: "A cupful, a wineglass." An attempt has been made to reduce these measures to some scale. In these liquid measures the glass is supposed to be filled ½ inch from the top. A "wineglass" is very apt to be a claret glass. If the diameter is 2¾ inches and the depth 2½ inches from rim to bottom, the glass will hold 3½ fl. oz. = 105 cubic centimeters. A sherry glass is also a common wine glass and is flaring. If its top is 2½ inches in diameter it should hold 1½ fl. oz., or 45 cubic centimeters, A liquor glass, usually called a whiskey glass, varies greatly, but if 3 inches high and 2½ inches in diameter and slightly flaring it holds 4 fl. oz., or 120 cubic centimeters. A cocktail glass is peculiar; the diameter of the "Union League" model is 2¼ inches, depth 1¾ inch, round flare, holds 2 fl. oz. = 60 cubic centimeters. A "liqueur" glass having a diameter of 1⅛ inches, 2⅛ inches deep, flaring sides, holds ⅔ of a fluid ounce, or 20 cubic centimeters. A straight-sided soda glass, 6¼ inches high by 2⅝ inches in diameter, holds 10 fl. oz., or 300 cubic centimeters. A ½ liter stein, 2⅞ inches in diameter and 3¾ inches deep, holds 10 fl. oz., or 300 cubic centimeters as ordinarily filled.

| | | | |
|---|---|---|---|
| 120 drops water | = 1 teaspoon | 2½ cups buckwheat flour | = 1 lb. |
| 60 " thick fluid | = 1 " | 5½ " coffee | = 1 " |
| 60 " " " | = 1 oz. | 6½ " tea | = 1 " |
| 2 teaspoons | = 1 dessert-spoon | 2 " rice | = 1 " |
| 3 " | = 1 tablespoon | 2 " lard | = 1 " |
| 16 tablespoons | = 1 cup | 2 " butter | = 1 " |
| 1 cup | = ½ pint | 2 " graham flour | = 1 " |
| 1 " water | = ½ lb. | 2 " rye flour | = 1 " |
| 4 tablespoons flour | = 1 oz. | 2 " corn meal | = 1 " |
| 2 tablespoons butter | = 1 " | 2 " rolled oats | = 1 " |
| 3 teaspoons soda | = ½ " | 2 " powdered sugar | = 1 " |
| 4 " baking powder | = ½ " | 2 " brown " | = 1 " |
| 2 cups granulated sugar | = 1 lb. | 2 " raisins | = 1 " |
| 2½ " confectioners' sugar | = 1 " | 2 " currants | = 1 " |
| 2½ " wheat flour | = 1 " | 2 " bread crumbs | = 1 " |
| 3½ " whole-wheat flour | = 1 " | 9 eggs | = 1 " |

## FOREIGN WEIGHTS AND MEASURES.

The following table embraces only such weights and measures as are given from time to time in CONSULAR REPORTS and in COMMERCIAL RELATIONS:

*Foreign weights and measures, with American equivalents.*

| Denominations. | Where Used. | American Equivalents. |
|---|---|---|
| Almude | Portugal | 4.422 gallons. |
| Ardeb | Egypt | 7.6907 bushels. |
| Are | Metric | 0.02471 acre. |
| Arobe | Paraguay | 25 pounds. |
| Arratel or libra | Portugal | 1.011 pounds. |
| Arroba (dry) | Argentine Republic | 25.3175 pounds. |
| Do | Brazil | 32.38 pounds. |
| Do | Cuba | 25.3664 pounds |
| Do | Portugal | 32.38 pounds. |
| Do | Spain | 25.36 pounds. |
| Do | Venezuela | 25.4024 pounds. |
| Arroba (liquid) | Cuba, Spain, and Venezuela | 4.263 gallons. |
| Arshine | Russia | 28 inches. |
| Arshine (square) | Do | 5.44 square feet. |
| Artel | Morocco | 1.12 pounds. |
| Baril | Argentine Republic and Mexico | 20.0787 gallons. |
| Barrel | Malta (customs) | 11.4 gallons. |
| Do | Spain (raisins) | 100 pounds. |
| Batman or tabriz | Persia | 6.49 pounds. |
| Berkovets | Russia | 361.12 pounds. |
| Bongkal | India | 832 grains. |
| Bouw | Sumatra | 7,096.5 square meters. |
| Bu | Japan | 0.1 inch. |
| Butt (wine) | Spain | 140 gallons. |
| Caffiso | Malta | 5.4 gallons. |
| Candy | India (Bombay) | 529 pounds. |
| Do | India (Madras) | 500 pounds. |
| Cantar | Morocco | 113 pounds. |
| Do | Syria (Damascus) | 575 pounds. |
| Do | Turkey | 124.7036 pounds. |
| Cantaro (cantar) | Malta | 175 pounds. |
| Carga | Mexico and Salvador | 300 pounds. |
| Catty | China | 1.33⅓ (1⅓) pounds. |
| Do.[1] | Japan | 1.31 pounds. |
| Do | Java, Siam, and Malacca | 1.35 pounds. |
| Do | Sumatra | 2.12 pounds. |
| Centaro | Central America | 4.2631 gallons. |
| Centner | Bremen and Brunswick | 117.5 pounds. |
| Do | Darmstadt | 110.24 pounds. |
| Do | Denmark and Norway | 110.11 pounds. |
| Do | Nuremberg | 112.43 pounds. |
| Do | Prussia | 113.44 pounds. |
| Do | Sweden | 93.7 pounds. |
| Do | Vienna | 123.5 pounds. |
| Do | Zollverein | 110.24 pounds. |

[1] More frequently called "kin." Among merchants in the treaty ports it equals 1.33⅓ pounds avoirdupois.

FOREIGN WEIGHTS AND MEASURES—*Continued.*

| Denominations. | Where Used. | American Equivalents. |
|---|---|---|
| Centner | Double or metric | 220.46 pounds. |
| Chetvert | Russia | 5.7748 bushels. |
| Chih | China | 14 inches. |
| Coyan | Sarawak | 3,098 pounds |
| Do. | Siam (Koyan) | 2,667 pounds. |
| Cuadra | Argentine Republic | 4.2 acres. |
| Do. | Paraguay | 78.9 yards. |
| Do. | Paraguay (square) | 8.077 square feet. |
| Do. | Uruguay | Nearly 2 acres. |
| Cubic meter | Metric | 35.3 cubic feet. |
| Cwt. (hundredweight) | British | 112 pounds. |
| Dessiatine | Russia | 2.6997 acres. |
| Do | Spain | 1.599 bushels. |
| Drachme | Greece | Half ounce. |
| Fanega (dry) | Central America | 1.5745 bushels. |
| Do. | Chile | 2.575 bushels. |
| Do. | Cuba | 1.599 bushels. |
| Do. | Mexico | 1.54728 bushels. |
| Do. | Morocco | Strike fanega, 70 pounds; full fanega, 118 pounds. |
| Do. | Uruguay (double) | 7.776 bushels. |
| Do. | Uruguay (single) | 3.888 bushels. |
| Do. | Venezuela | 1.599 bushels. |
| Fanega (liquid) | Spain | 16 gallons. |
| Feddan | Egypt | 1.03 acres. |
| Frail (raisins) | Spain | 50 pounds. |
| Frasco | Argentine Republic | 2.5096 quarts. |
| Do. | Mexico | 2.5 quarts. |
| Frasila | Zanzibar | 35 pounds. |
| Fuder | Luxemburg | 264.17 gallons. |
| Funt | Russia | 0.9028 pound. |
| Garnice | Russian Poland | 0.88 gallon. |
| Gram | Metric | 15.432 grains. |
| Hectare | Do. | 2.471 acres. |
| Hectoliter. | | |
| Dry | Do. | 2.838 bushels. |
| Liquid | Do. | 26.417 gallons. |
| Joch | Austria-Hungary | 1.422 acres. |
| Ken | Japan | 6 feet. |
| Kilogram (kilo) | Metric | 2.2046 pounds. |
| Kilometer | Do. | 0.621376 mile. |
| Klafter | Russia | 216 cubic feet. |
| Koku | Japan | 4.9629 bushels. |
| Korree | Russia | 3.5 bushels |
| Kwan | Japan | 8.28 pounds. |
| Last | Belgium and Holland | 85.134 bushels. |
| Do. | England (dry malt) | 82.52 bushels. |
| Do. | Germany | 2 metric tons (4,480 pounds). |
| Do. | Prussia | 112.29 bushels. |
| Do. | Russian Poland | 11⅜ bushels. |
| Do. | Spain (salt) | 4,760 pounds. |
| League (land) | Paraguay | 4,633 acres. |
| Li | China | 2,115 feet. |
| Libra (pound) | Argentine Republic | 1.0127 pounds. |
| Do. | Central America | 1.043 pounds. |
| Do. | Chile | 1.014 pounds. |
| Do. | Cuba | 1.0161 pounds. |
| Do. | Mexico | 1.01465 pounds. |
| Do. | Peru | 1.0143 pounds. |
| Do. | Portugal | 1.011 pounds. |
| Do. | Spain | 1.0144 pounds. |
| Do. | Uruguay | 1.0143 pounds. |
| Do. | Venezuela | 1.0161 pounds. |
| Liter | Metric | 1.0567 quarts. |
| Livre (pound) | Greece | 1.1 pounds. |
| Do. | Guiana | 1.0791 pounds. |
| Load | England (timber) | Square, 50 cubic feet; unhewn, 40 cubic feet; inch planks, 600 superficial feet. |
| Manzana | Costa Rica | 1⅝ acres. |
| Do | Nicaragua and Salvador | 1.727 acres. |

FOREIGN WEIGHTS AND MEASURES—*Continued.*

| Denominations. | Where Used. | American Equivalents. |
|---|---|---|
| Marc | Bolivia | 0.507 pound. |
| Maund | India | 82⅔ pounds. |
| Meter | Metric | 39.37 inches. |
| Mil | Denmark | 4.68 miles. |
| Do. | Denmark (geographical) | 4.61 miles. |
| Milla | Nicaragua and Honduras | 1.1493 miles. |
| Morgen | Prussia | 0.63 acre. |
| Oke | Egypt | 2.7225 pounds. |
| Do. | Greece | 2.84 pounds. |
| Do. | Hungary | 3.0817 pounds. |
| Do. | Turkey | 2.82838 pounds. |
| Do. | Hungary and Wallachia | 2.5 pints. |
| Pic | Egypt | 21¼ inches. |
| Picul | Borneo and Celebes | 135.64 pounds. |
| Do. | China, Japan, and Sumatra | 133⅓ pounds. |
| Do. | Java | 135.1 pounds. |
| Do. | Philippine Islands | 137.9 pounds. |
| Pie | Argentine Republic | 0.9478 foot. |
| Do. | Spain | 0.91407 foot. |
| Pik | Turkey | 27.9 inches. |
| Pood | Russia | 36.112 pounds. |
| Pund (pound) | Denmark and Sweden | 1.102 pounds. |
| Quarter | Great Britain | 8.252 bushels. |
| Do. | London (coal) | 36 bushels. |
| Quintal | Argentine Republic | 101.42 pounds. |
| Do. | Brazil | 130.06 pounds. |
| Do. | Castile,[1] Chile, Mexico, and Peru | 101.41 pounds. |
| Do. | Greece | 123.2 pounds. |
| Do. | Newfoundland (fish) | 112 pounds. |
| Do. | Paraguay | 100 pounds. |
| Do. | Syria | 125 pounds. |
| Do. | Metric | 220.46 pounds |
| Rottle | Palestine | 6 pounds. |
| Do. | Syria | 5¾ pounds. |
| Sagene | Russia | 7 feet. |
| Salm | Malta | 490 pounds. |
| Se | Japan | 0.02451 acre. |
| Seer | India | 1 pound 13 ounces. |
| Shaku | Japan | 11.9305 inches. |
| Sho | Do. | 1.6 quarts. |
| Standard (St. Petersburg) | Lumber measure | 165 cubic feet. |
| Stone | British | 14 pounds. |
| Suerte | Uruguay | 2,700 cuadras (see cuadra). |
| Sun | Japan | 1.193 inches. |
| Tael | Cochin China | 590.75 grains (troy). |
| Tan | Japan | 0.25 acre. |
| To | Do. | 2 pecks. |
| Ton | Space measure | 40 cubic feet. |
| Tonde (cereals) | Denmark | 3.94783 bushels. |
| Tondeland | Do. | 1.36 acres. |
| Tsubo | Japan | 6 feet square. |
| Tsun | China | 1.41 inches. |
| Tunna | Sweden | 4.5 bushels. |
| Tunnland | Sweden | 1.22 acres. |
| Vara | Argentine Republic | 34.1208 inches. |
| Do. | Central America | 32.87 inches. |
| Do. | Chile and Peru | 33.367 inches. |
| Do. | Cuba | 33.384 inches. |
| Do. | Curacao | 33.375 inches. |
| Do. | Mexico | 33 inches. |
| Do. | Paraguay | 34 inches. |
| Do. | Spain | 0.914117 yard. |
| Do. | Venezuela | 33.384 inches. |
| Vedro | Russia | 2.707 gallons. |
| Vergees | Isle of Jersey | 71.1 square rods. |
| Verst | Russia | 0.663 mile. |
| Vlocka | Russian Poland | 41.98 acres. |

[1] Although the metric weights are used officially in Spain, the Castile quintal is employed in commerce in the Peninsula and colonies, save in Catalonia; the Catalan quintal equals 91.71 pounds.

## DECIMAL SYSTEM—WEIGHTS AND MEASURES.

A *meter* is one ten-millionth of the distance from the equator to the North Pole.

The metric system, formed on the meter as the unit of length, has four other leading units, all connected with and dependent upon this. The *are*, the unit of surface, is the square of ten meters. The *liter*, the unit of capacity, is the cube of a tenth part of the meter. The *stere*, the unit of solidity, has the capacity of a cubic meter. The *gram*, the unit of weight, is the weight of that quantity of distilled water at its maximum density which fills the cube of a hundredth part of the meter. Each unit has its decimal multiple and submultiple, that is, weights and measures ten times larger or ten times smaller than the principal unit. The prefixes denoting the multiples are derived from the Greek, and are *deca*, ten; *hecto*, hundred; *kilo*, thousand; and *myria*, ten thousand. Those denoting sub-multiples are taken from the Latin, and are *deci*, ten; *centi*, hundred; *milli*, thousand.

| Relative Value. | Length. | Surface. | Capacity. | Solidity. | Weight. |
|---|---|---|---|---|---|
| 10,000. | Myriameter | | | | |
| 1,000. | Kilometer | | Kiloliter | | Kilogram |
| 100. | Hectometer | Hectare | Hectoliter | | Hectogram |
| 10. | Decameter | | Decaliter | Dekastere | Decagram |
| Unit. | Meter | Are | Liter | Stere | Gram |
| 0.1. | Decimeter | Deciare | Deciliter | Decistere | Decigram |
| 0.01. | Centimeter | Centiare | Centiliter | | Centigram |
| 0.001. | Millimeter | | Milliliter | | Milligram |

## APPROXIMATE EQUIVALENTS OF THE FRENCH (METRIC) AND ENGLISH MEASURES.

| | |
|---|---|
| 1 yard | $1\frac{1}{9}$ meter. |
| 11 meters | 12 yards. |
| To convert meters into yards | Add $\frac{1}{11}$th. |
| 1 meter = 1.1 yd.; 3.3 ft | 3 ft. $3\frac{3}{8}$ inches ($\frac{1}{32}$th less). 40 inches (1.6 per cent less). |
| 1 meter, by the Standards Commission | = 39.38203 inches. |
| 1 meter, by the Act of 1878 | = 39.37079 inches. |
| 1 foot | 3 decimeters (more exactly 3.048). |
| 1 inch | 25 millimeters (more exactly 25.4). |
| 1 mile | 1.6 or $1\frac{3}{5}$ kilometers (more exactly 1.60931) |
| 1 kilometer | $\frac{5}{8}$ of a mile. |
| 1 chain (22 yards) | 20 meters (more exactly 20.1165). |
| 5 furlongs (1,100 yards) | 1 kilometer (more exactly 1.0058). |
| 1 square yard | $\frac{6}{7}$ square meter (more exactly .8361). |
| 1 square meter | $10\frac{3}{4}$ square feet. $1\frac{1}{5}$ square yards. |
| 1 square inch | $6\frac{1}{2}$ square centimeters (more exactly 6.45). |
| 1 square mile (640 acres) | 260 hectares (0.4 per cent less). |
| 1 acre (4840 square yards) | 4000 square meters (1.2 per cent more). |
| 1 cubic yard | $\frac{4}{5}$ cubic meter (2 per cent more). |
| 1 cubic meter | $1\frac{1}{3}$ cubic yards ($1\frac{1}{4}$ per cent less). |
| 1 cubic meter | $35\frac{1}{3}$ cubic feet (.05 per cent less). |
| 1 cubic meter of water | 1 long ton nearly. |
| 1 kilogram | 2.2 pounds fully. |
| 1,000 kilograms | 1 long ton nearly. |
| 1 metric ton | |
| 1 long hundredweight | 51 kilograms nearly. |
| 1 United States hundredweight | $45\frac{1}{2}$ kilograms nearly . |

# METRIC MEASURES.

| Measures. | Metric to Customary. | | | Customary to Metric. | | |
|---|---|---|---|---|---|---|
| LENGTHS | 1 Millimeter | = 0.03937 | inch | 1 Inch | = 25.4001 | millimeters |
| | 1 Centimeter | = 0.3937 | " | 1 " | = 2.54001 | centimeters |
| | 1 Meter | = 39.37 | " | 1 " | = 0,0254 | meter |
| | 1 " | = 3.28083 | feet | 1 Foot | = 0.304801 | " |
| | 1 " | = 1.093611 | yards | 1 Yard | = 0.914402 | " |
| | 1 Kilometer | = 0.62137 | mile | 1 Mile | = 1.60935 | kilometers |
| AREAS | 1 Square Millimeter | = 0.00155 | square inch | 1 Square Inch | = 645.16 | square millimeters |
| | 1 " Centimeter | = 0.1550 | " " | 1 " " | = 6.452 | " centimeters |
| | 1 " Meter | = 10.764 | " feet | 1 " Foot | = 0.0929 | " meter |
| | 1 " " | = 1.1960 | " yards | 1 " Yard | = 0.8361 | " " |
| | 1 " Kilometer | = 0.3861 | " mile | 1 " Mile | = 2.5900 | " kilometers |
| | 1 Hectare | = 2.471 | acres | 1 Acre | = 0.4047 | hectares |
| VOLUMES | 1 Cubic Millimeter | = 0.000061 | cubic inch | 1 Cubic Inch | = 16,387.2 | cubic millimeters |
| | 1 " Centimeter | = 0.0610 | " " | 1 " " | = 16.3872 | " centimeters |
| | 1 " Meter | = 35.314 | " feet | 1 " Foot | = 0.02832 | " meter |
| | 1 " " | = 1.3079 | " yard | 1 " Yard | = 0.7645 | " " |
| CAPACITY. *Liquid* | 1 Liter | = 1.05668 | quarts | 1 Quart | = 0.94636 | liter |
| | 1 " | = 0.26417 | gallon | 1 Gallon | = 3.78543 | " |
| *Dry* | 1 Liter | = 0.9081 | quart | 1 Quart | = 1.1012 | liters |
| | 1 " | = 0.11351 | peck | 1 Peck | = 8.80982 | " |
| | 1 Decaliter | = 1.1351 | " | 1 " | = 0.8810 | decaliter |
| | 1 Hectoliter | = 2.83774 | bushels | 1 Bushel | = 0.35239 | hectoliter |
| MASSES. *Avoirdupois* | 1 Gram | = 15.4324 | grains | 1 Grain | = 0.06480 | gram |
| | 1 " | = 0.03527 | ounce | 1 Ounce | = 28.3495 | " |
| | 1 Kilogram | = 2.20462 | pounds | 1 Pound | = 0.45359 | kilogram |
| *Troy* | 1 Gram | = 0.03215 | ounce | 1 Ounce. | = 31.10348 | grams |
| | 1 Kilogram | = 2.67923 | pounds | 1 Pound | = 0.37324 | kilogram |
| *Apothecaries'* | 1 Gram | = 0.2705 | dram | 1 Dram | = 3.6967 | grams |
| | 1 " | = 0.8115 | scruple | 1 Scruple | = 1.2322 | " |

## FRENCH AND ENGLISH COMPOUND EQUIVALENTS.

| | |
|---|---|
| 1 kilogram per linear meter | .672 pound per linear foot.<br>2.016 pounds per yard. |
| 1,000 kilograms (1 ton) per meter | .300 long ton per foot; $\frac{1}{3}$ short ton per foot. |
| 1 kilogram per kilometer | 3.548 pounds per mile. |
| 1,000 kilograms (1 ton) per kilometer | 1.584 long tons per mile; 1.774 short tons per mile. |
| 1 kilogram per square millimeter | 1422.32 pounds per square inch; .635 long ton per square inch; .711 short ton per sq. in. |
| 1 kilogram per square centimeter | 14.2232 pounds per square inch. |
| 1 kilogram per square decimeter | 20.481 pounds per square foot. |
| 1 kilogram per square meter | 1.843 pounds per square yard. |
| 1,000 kilograms (1 ton) per square meter | .8229 long ton, .922 short ton, per square yard. |
| 1 kilogram per ton | 2.240 pounds per long ton; 2 pounds per short ton. |
| 1 kilogram per ton per kilometer | 3.6042 pounds per long ton per mile. |
| 1 liter of water at 4° C. per ton per kilometer | .4325 U. S. gal. at 62° F. per long ton per mile. |
| 1 gram per square millimeter | 1.422 pounds per square inch. |
| 1 gram per square centimeter | .01422 pound per square inch. |
| 1 kilogram per cubic meter | .1686 pound per cubic yard.<br>.0624 pound per cubic foot. |
| 1,000 kilograms (1 ton) per cubic meter | .984 long ton per cubic meter.<br>.752 ton per cubic yard. |
| 1 cubic meter per kilogram | 16.019 cubic feet per pound. |
| 1 cubic meter per ton | 1.329 cubic yards per long ton.<br>35.882 cubic feet per long ton. |
| 1 cubic meter per kilometer | 2.105 cubic yards per mile. |
| 1 cubic meter per linear meter | 1.196 cubic yards per linear yard. |
| 1 cubic meter per square meter | 3.281 cubic feet per square foot. |
| 1 cubic meter per hectare | .405 cubic meter per acre.<br>.529 cubic yard per acre. |
| 1 kilogrammeter | 7.233 foot-pounds. |
| 1 kilogrammeter | =0.00323 foot-ton (long)=.00362 foot-ton (short). |
| 1 ton-meter | 3 foot-tons (long); 3.36 (short). |
| 1 cheval vapeur, or cheval (75k×m per second) | .9863 horse-power. |
| 1 kilogram per cheval | 2.235 pounds per horse-power. |
| 1 square meter per cheval | 10.913 square feet per horse-power. |
| 1 cubic meter per cheval | 35.806 cubic feet per horse-power. |
| 1 calorie, or French unit of heat | 3.968 British heat-units. |
| French mechanical equivalent of heat (423.55k×m) | 3063.5 foot-pounds. |
| 1 calorie per square meter | .369 heat-unit per square foot. |
| 1 calorie per kilogram | 1.800 heat-units per pound. |

### ENGLISH AND FRENCH.

| | |
|---|---|
| 1 pound per linear foot | 1.488 kilograms per linear meter. |
| 1 pound per yard | .496 kilogram per meter. |
| 1 long ton per foot | 33.32 kilograms ($3\frac{1}{4}$ tons approx.) per meter. |
| 1 long ton per yard | 1111 kilograms ($1\frac{1}{10}$ tons approx.) per meter. |
| 1 pound per mile | .2818 kilogram per kilometer. |
| 1 long ton per mile | .6313 ton per kilometer. |
| 1 pound per long ton | .4464 kilogram per ton. |
| 1 pound per long ton per mile | .2774 kilogram per ton per kilometer. |
| 1 pound per square inch | .0703077 kilogram per square centimeter.<br>.7031 gram per square millimeter.<br>5.170 centimeters of mercury at 0° C. |
| 1 atmosphere (14.7 pounds per square inch) | 1.0335 kilograms per square centimeter. |
| 1,000 pounds per square inch | .703077 kilogram per square millimeter. |
| 2,000 pounds per square inch | 1.406154 kilograms per square millimeter. |
| 1 long ton per square inch | 1.575 kilograms per square millimeter. |
| 1 pound per square foot | 4.883 kilograms per square meter. |
| 1,000 pounds per square foot | 4882.517 kilograms per square meter. |
| 1 ton per square foot | 10.935 tons per square meter. |
| 1,000 pounds per square yard | 542.500 kilograms per square meter. |
| 1 ton per square yard | 1.215 tons per square meter. |
| 1 pound per cubic yard | .5933 kilogram per cubic meter. |
| 1 pound per cubic foot | 16.020 kilograms per cubic meter. |
| 1 ton per cubic yard | 1.329 tons per cubic meter. |
| 1 cubic yard per pound | 1.6855 cubic meters per kilogram. |
| 1 cubic yard per ton | .7525 cubic meter per ton. |
| 1 cubic yard per mile | .4750 cubic meter per kilometer. |
| 1 cubic yard per linear yard | .836 cubic meter per linear meter. |
| 1 cubic foot per square foot | .3048 cubic meter per square meter. |
| 1 cubic meter per acre | 2.471 cubic meters per hectare. |
| 1 cubic yard per acre | 1.889 cubic meters per hectare. |
| 1 foot-pound | .1382 kilogrammeter. |

FRENCH AND ENGLISH COMPOUND EQUIVALENTS—*Continued.*

| | |
|---|---|
| 1 foot-ton (long) | .3097 ton-meter. |
| 1 horse-power | 1.0139 cheval. |
| 1 pound per horse-power | .447 kilogram per cheval. |
| 1 square foot per horse-power | .0916 square meter per cheval. |
| 1 cubic foot per horse-power | .0279 cubic meter per cheval. |
| 1 British unit of heat, or heat-unit | .252 calorie. |
| British mechanical equivalent of one heat-unit (772 foot-pounds) | 106.7 kilogrammeters. |
| 1 British heat-unit per square foot | 2.713 calories per square meter. |
| 1 British heat-unit per pound | $\frac{5}{9}$ calorie per kilogram. |

—D. K. Clark, Mechanical Engineer's Pocket Book.

To Reduce Parts by Volume, or Measure to Parts by Weight.—Multiply the parts by volume, or measure, by the specific gravity of the different substances: the result will be parts by weight.

## MENSURATION.

### SURFACES.

Parallelogram.—Area equals base multiplied by height.

Triangle.—Base and height given. Multiply base by height and divide by two.

When three sides are given. From the half sum of the three sides subtract each side separately; multiply the half sum and the three remainders together. The area is the square root of the product thus obtained.

Trapezium (a figure with two sides parallel and two sides not parallel).—To find the area multiply the sum of the two parallel sides by the distance between them and divide by two.

Square or Rhombus (an oblique parallelogram with four equal sides).—Area equals half the product of the diagonals.

Irregular Polygon.—The area may be found by dividing it into a series of triangles and trapeziums, and finding the sum of the areas thus obtained.

Regular Polygon.—Area equals number of sides multiplied by length of one side and by the radius of the inscribed circle divided by two.

Circle.—Circumference equals diameter multiplied by 3.1416, or approximately by $3\frac{1}{7}$. Area equals diameter squared multiplied by .7854.

Sector of Circle.—Multiply the length of the arc by the radius and divide by two.

Segment of Circle.—Find the area of the sector having the same arc. Also find area of triangle formed by the radial sides and the chord. The area equals the sum or difference of these according as the segment is greater or less than a semicircle.

Annulus.—Multiply the sum of the diameters by their difference and by .7854.

Square Equal to a Circle.—Side of square equals diameter multiplied by .8862.

Inscribed Square.—Side of square equals diameter multiplied by .7071.

Ellipse.—Area equals the product of the two axes by .7854.

### SOLIDS.

Cube.—Surface equals length of one edge squared and multiplied by six. Contents equals length of one edge cubed.

Cylinders and Prisms.—Surface equals perimeter of one end multiplied by height plus twice the area of one end. Contents equals area of base multiplied by height. This last also applies to oblique cylinders and prisms.

Cone or Pyramid.—Surface equals circumference of base multiplied by slant height divided by two, plus the area of the base. Contents equals area of base multiplied by one-third perpendicular height. This last applies whether the cones and pyramids be right or oblique.

Frustum of Cone or Pyramid.—Contents: To the sum of the area of the two ends add the square root of their product and multiply the quantity thus obtained by one-third the perpendicular height.

Sphere.—Area equals square of diameter multiplied by 3.1416 or $3\frac{1}{7}$; *i.e.*, it is equal to four times the area of one of its great circles, or to the convex surface of its circumscribing cylinder. Surfaces of spheres vary as the squares of their diameters. Contents equal the cube of the diameter multiplied by .5236, *i.e.*, equals area of surface multiplied by diameter and divided by six. Contents of spheres vary as the cubes of the diameter.

Segment of Sphere.—Contents: From three times the diameter of the sphere subtract twice the height of the segment, multiply the difference by the square of the height and by .5236; or, another rule: Add the square of the height to three times the square of the radius of the base and multiply the sum by the height and by .5236.

Zone of Sphere.—To the sum of the squares of the radii of the two ends add one-third the square of the height, multiply the sum by the height and by 1.5708.

Cone, Sphere, and Cylinder.—The contents of a cone, sphere, and cylinder of same diameter and height are in the ratio of 1 to 2 to 3.—*Practical Engineer's Electrical Pocket Book and Diary.*

## CIRCULAR MEASURE.

Diameter of a Circle × 3.1416 gives Circumference.

Diameter Squared × .7854 gives Area of Circle.

Diameter Squared × 3.1416 gives Surface of Sphere.

Diameter Cubed × .5236 gives Solidity of Sphere.

One Degree of Circumference × 57.3 gives Radius.

Diameter of Cylinder × 3.1416, and product by its length, gives the Surface.

Diameter Squared × .7854, and product by the length, gives Solid Contents.

A Circular Acre is 225.504 feet, a Circular Rood 117.752 feet, in diameter. The Circumference of the globe is about 24,855 miles, and the Diameter about 7,900 miles.—*Whittaker's Almanac.*

## ANGULAR MEASURE.

There is perfect unanimity as to the standard angle (i.e., the right angle) and practical unanimity as to its subdivision, for the subdivision into grades, etc., once favored by the French, is now abandoned.

| | | |
|---|---|---|
| 1 minute of angle or arc | = | 60 seconds. |
| 1 degree " " " " | = | 60 minutes. |
| 90 degrees " " " " | = | 1 right angle or ¼ of circumference. |
| Radian " " " " | = | arc same length as radius. |
| " " " " " | = | 57.295779513082°. |
| Length of arc of 1° | = | 0.017453292520. |
| Length of arc of 1′ | = | 0.000290888209. |
| " " " " 1″ | = | 0.015707963268. |

## TIME.

The unit of time measurement is the same among all nations. Practically it is $\frac{1}{86400}$ of the mean solar day, but really it is a perfectly arbitrary unit, as the length of the mean solar day is not constant for any two periods of time. There is no constant natural unit of time.

| | |
|---|---|
| 1 minute | = 60 seconds. |
| 1 hour | = 60 minutes, 3600 seconds. |
| 1 day | = 24 hours, 1440 minutes, 86,400 seconds. |
| 1 sidereal day | = 86164.1 seconds. |
| 1 sidereal month | = 27.321661 mean solar days (average). |
| 1 lunar month | = 29.530589 mean solar days (average). |
| 1 anomalistic month | = 27.544600 mean solar days (average). |
| 1 tropical month | = 27.321582 mean solar days (average). |
| 1 nodical month | = 27.212222 mean solar days (average). |
| Mean solar year | = 365 d. 5 h. 48 m. 46.045 s. with annual variation of 0.00539. |

The change in the length of the mean sidereal day, i.e., of the time of the earth's rotation upon its axis, amounts to 0.01252 s. in 2400 mean solar years.

—*Physical Tables.*

## TABLE OF DECIMAL EQUIVALENTS OF FRACTIONS OF AN INCH.

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1/64 | = | ·015625 | 17/64 | = | 34375 | 33/64 | = | ·671875 | 49/64 | = | ·765625 |
| 1/32 | = | ·03125 | 23/64 | = | ·359375 | 11/16 | = | ·6875 | 25/32 | = | ·78125 |
| 3/64 | = | ·046875 | 3/8 | = | ·375 | 45/64 | = | ·703125 | 51/64 | = | ·796875 |
| 1/16 | = | ·0625 | 25/64 | = | ·390625 | 23/32 | = | ·71875 | 13/16 | = | ·8125 |
| 5/64 | = | ·078125 | 13/32 | = | ·40625 | 47/64 | = | ·734375 | 53/64 | = | ·828125 |
| 3/32 | = | ·09375 | 27/64 | = | ·421875 | 3/4 | = | ·75 | 27/32 | = | ·84375 |
| 7/64 | = | ·109375 | 7/16 | = | ·4375 | 49/64 | = | ·765625 | 55/64 | = | ·859375 |
| 1/8 | = | ·125 | 29/64 | = | ·453125 | 25/32 | = | ·78125 | 7/8 | = | ·875 |
| 9/64 | = | ·140625 | 15/32 | = | ·46875 | 51/64 | = | ·796875 | 57/64 | = | ·890625 |
| 5/32 | = | ·15625 | 31/64 | = | ·484375 | 13/16 | = | ·8125 | 29/32 | = | ·90625 |
| 11/64 | = | ·171875 | 1/2 | = | ·50 | 53/64 | = | ·828125 | 59/64 | = | ·921875 |
| 3/16 | = | ·1875 | 33/64 | = | ·515625 | 27/32 | = | ·84375 | 15/16 | = | ·9375 |
| 13/64 | = | ·203125 | 17/32 | = | ·53125 | 55/64 | = | ·859375 | 61/64 | = | ·953125 |
| 7/32 | = | ·21875 | 35/64 | = | ·546875 | 7/8 | = | ·875 | 31/32 | = | ·96875 |
| 15/64 | = | ·234375 | 9/16 | = | ·5625 | 57/64 | = | ·890625 | 63/64 | = | ·984375 |
| 1/4 | = | ·25 | 37/64 | = | ·578125 | 29/32 | = | ·90625 | | | |
| 17/64 | = | ·265625 | 19/32 | = | ·59375 | 59/64 | = | ·921875 | | | |
| 9/32 | = | ·28125 | 39/64 | = | ·609475 | 15/16 | = | ·9375 | | | |
| 19/64 | = | ·296875 | 5/8 | = | ·625 | 61/64 | = | ·953125 | | | |
| 5/16 | = | ·3125 | 41/64 | = | ·640625 | 31/32 | = | ·96875 | | | |
| 21/64 | = | ·328125 | 21/32 | = | ·65625 | 63/64 | = | ·984375 | | | |

## WEIGHTS AND MEASURES OF THE BIBLE.

### WEIGHTS.

| | Avoirdupois. Lbs. | Oz. | Drs. | | Lbs. | Troy. Oz. | Dwt. | Gr. |
|---|---|---|---|---|---|---|---|---|
| A gerah | 0 | 0 | 0.439 | = | 0 | 0 | 0 | 12 |
| 10 gerahs = 1 bekah | 0 | 0 | 4.39 | = | 0 | 0 | 5 | 0 |
| 2 bekahs = 1 shekel | 0 | 0 | 8.78 | = | 0 | 0 | 10 | 0 |
| 60 shekels = 1 maneh | 2 | 0 | 14.628 | = | 2 | 6 | 0 | 0 |
| 50 manehs = 1 talent | 102 | 13 | 11.428 | = | 125 | 0 | 0 | 0 |

### MEASURES.

| Long Measure. | Ft. | In. |
|---|---|---|
| A digit, or finger (Jer. lii. 21) | 0 | 0.912 |
| 4 digits = 1 palm (Exod. xxv. 25) | 0 | 3.648 |
| 3 palms = 1 span (Exod. xxviii. 16) | 0 | 10.944 |
| 2 spans = 1 cubit (Gen. vi. 15) | 1 | 9.888 |
| 4 cubits = 1 fathom (Acts xxvii. 28) | 7 | 3.552 |
| 1.5 fathoms = 1 reed (Ezek. xl. 3, 5) | 10 | 11.328 |
| 13.3 reeds = 1 line (Ezek. xl. 3) | 145 | 11.04 |

| Land Measure. | Eng. miles. | Paces. | Ft. |
|---|---|---|---|
| A cubit | 0 | 0 | 1.824 |
| 400 cubits = 1 furlong (Luke xxiv. 13) | 0 | 145 | 4.6 |
| 5 furlongs = 1 sabbath day's journey (John xi. 18; Acts i. 12) | 0 | 727 | 3.0 |
| 10 furlongs = 1 mile (Matt. v. 41) | 1 | 399 | 1.0 |
| 24 miles = 1 day's journey | 33 | 76 | 4.0 |

| Liquid Measure. | Gals. | Pts. |
|---|---|---|
| A caph | 0 | 0.625 |
| 1.3 caphs = 1 log (Lev. xiv. 10) | 0 | 0.833 |
| 4 logs = 1 cab | 0 | 3.333 |
| 3 cabs = 1 hin (Exod. xxx. 24) | 1 | 2 |
| 2 hins = 1 seah | 2 | 4 |
| 3 seahs = 1 bath, or ephah (1 Kings vii. 26; John ii. 6) | 7 | 4.5 |
| 10 ephahs = 1 kor, or homer (Isa. v. 10; Ezek. xiv. 14) | 75 | 5.25 |

## WEIGHTS AND MEASURES OF THE BIBLE—*Continued.*

### Dry Measure.

| | Pecks. | Gals. | Pts. |
|---|---|---|---|
| A gachal | 0 | 0 | 0.1416 |
| 20 gachals = 1 cab (2 Kings vi. 25; Rev. vi. 6) | 0 | 0 | 2.8333 |
| 1.8 cabs = 1 omer (Exod. xvi. 36) | 0 | 0 | 5.1 |
| 3.3 omers = 1 seah (Matt. xiii. 33) | 1 | 0 | 1 |
| 3 seahs = 1 ephah (Ezek. xlv. 11) | 3 | 0 | 3 |
| 5 ephahs = 1 letech (Hosea iii. 2) | 16 | 0 | 0 |
| 2 letechs = 1 kor, or homer (Num. xi 32; Hos. iii. 2) | 32 | 0 | 0 |

N.B.—The above Table will explain many texts in the Bible. Take, for instance, Isa. v. 10· "Yea, ten acres of vineyard shall yield one bath, and the seed of an homer shall yield an ephah." This curse upon the covetous man was, that 10 acres of vines should produce only 7 gallons of wine, i.e., one acre should yield less that 3 quarts; and that 32 pecks of seed should only bring a crop of 3 pecks, or, in other words, that the harvest reaped should produce but one-tenth of the seed sown.

## TIME.

The *Natural* Day was from sun-rise to sun-set.
The *Natural* Night was from sun-set to sun-rise.
The *Civil* Day was from sun-set one evening to sun-set the next; for, "the Evening and the Morning were the first day."

| Night (*Ancient*). | Day (*Ancient*). |
|---|---|
| First Watch (Lam. ii. 19) till midnight. | Morning till about 10 a.m. |
| Middle Watch (Judg. vii. 19) till 3 a.m. | Heat of day till about 2 p.m. |
| Morning Watch (Exod. xiv. 24) till 6 a.m. | Cool of day till about 6 p.m. |

| Night (*New Testament*). | Day (*New Testament*). |
|---|---|
| First Watch, *evening* = 6 to 9 p.m. | Third hour = 6 to 9 a.m. |
| Second Watch, *midnight* = 9 to 12 p.m. | Sixth hour = 9 to 12 midday. |
| Third Watch, *cock-crow* = 12 to 3 a.m. | Ninth hour = 12 to 3 p m. |
| Fourth Watch, *morning* = 3 to 6 a.m. | Twelfth hour = 3 to 6 p.m. |

## JEWISH MONEY.

*With its value in English and American money; the American dollar being taken as equal to* 4*s.* 2*d.*

| Jewish. | | English. £ | *s.* | *d.* | | American. *Dols.* | *Cents.* |
|---|---|---|---|---|---|---|---|
| A gerah (Exod. xxx. 13) | = | 0 | 0 | 1.36 | = | 0 | 2.73 |
| 10 gerahs = 1 bekah (Exod. xxxviii. 26) | = | 0 | 1 | 1.68 | = | 0 | 27.37 |
| 2 bekahs = 1 shekel (Exod. xxx. 13; Isa. vii. 23) | = | 0 | 2 | 3.37 | = | 0 | 54.74 |
| 50 shekels = 1 maneh | = | 5 | 14 | 0.75 | = | 27 | 37.50 |
| 60 manehs = 1 kikkar (talent) | = | 342 | 3 | 9 | = | 1,642 | 50 |
| A *gold* shekel | = | 1 | 16 | 6 | = | 8 | 76 |
| A kikkar of gold | = | 5,475 | 0 | 0 | = | 26,280 | 0 |

N.B.—A *shekel* would probably purchase nearly ten times as much as the same nominal amount will now. Remember that one *Roman* penny (8½*d.*) was a good day's wages for a laborer.

The Hebrew *maneh*, according to 1 Kings x. 17, compared with 2 Chron. ix. 16, contained 100 shekels; though according to one interpretation of Ezek. xlv. 12, it contained 60, but more probably 50. The passage reads thus:—"Twenty shekels, five and twenty shekels fifteen shekels shall be your maneh." This is variously interpreted, (1) 20+25+15 = 60. (2) 20, 25, 15 are different coins in gold, silver, and copper, bearing the same name. It is well to remark the meaning of these names: Shekel = simply *weight:* Bekah = *split*, i.e., the shekel divided into two: Gerah = a *grain*, as in our weights, a grain and a *barley-corn*, the original standard weight: Maneh = *appointed*, equivalent to *sterling*, a specific sum: Kikkar = a *round* mass of metal, i.e., a weight or coin. Hebrew names of weights and coins are not found in the New Testament: *mna* in Luke xix. 13 is Greek, though possibly identical with the Hebrew *maneh*.

## ROMAN MONEY.

| Roman. | English. *d.* | | American. *Cents.* |
|---|---|---|---|
| A "farthing," *quadrans* (Matt. v. 26) = nearly | 0.125 | = | 0.25 |
| A "farthing," *as* = 4 *quadrantes* (Matt. x. 29) = nearly | 0.5 | = | 1 |
| A "penny," *denarius* = 16 *asses* (Matt. xxii. 19) = nearly | 8.50 | = | 17 |

[The Roman sestertius = 2½ asses, is not named in the Bible.]

N.B.—Here we learn that—

Naaman's offering to Elisha of 6,000 pieces (shekels) of gold amounted to more than £10,000 = 48,000 *dollars.*

The Debtor (Matt. xviii. 24) who had been forgiven 10,000 talents, i.e., £3,000,000 = 14,400,000 *dollars*, refused to forgive his fellow-servant 100 pence, i.e., £3 10*s.* 10*d* = 17 *dollars.*

Judas sold our Lord for 30 pieces of silver, i.e., £3 10*s.* 8*d.* = 16 *dollars* 96 *cents*, the legal value of a slave, if he were killed by a beast.

Joseph was sold by his brethren for 20 pieces, i.e. £2 7*s.* = 11 *dollars* 28 *cents.*

—*Oxford University Bible.*

## TIME AND WATCH ON BOARD SHIP.

WATCH.—For purposes of discipline, and to divide the work fairly, the crew is mustered in two divisions: the Starboard (right side, looking forward) and the Port (left). The day commences at noon, and is thus divided:—

| | | |
|---|---|---|
| Afternoon *Watch* | .... | noon to 4 p.m. |
| First Dog " | .... | 4 p.m. to 6 p.m. |
| Second Dog " | .... | 6 p.m. to 8 p.m. |
| First " | .... | 8 p.m. to midnight. |
| Middle " | .... | 12 p.m. to 4 a.m. |
| Morning " | .... | 4 a.m. to 8 a.m. |
| Forenoon " | .... | 8 a.m. to noon. |

This makes seven WATCHES, which enables the crew to keep them alternately, as the *Watch* which is on duty in the forenoon one day has the afternoon next day, and the men who have only four hours' rest one night have eight hours the next. This is the reason for having *Dog Watches*, which are made by dividing the hours between 4 p.m. and 8 p.m. into two *Watches*.

TIME.—Time is kept by means of "Bells," although there is but one bell on the ship, and to strike the clapper properly against the bell requires some skill.

First, two strokes of the clapper at the interval of a second, then an interval of two seconds; then two more strokes with a second's interval apart, then a rest of two seconds, thus:—

BELL, ONE SECOND; B., TWO SECS.; B. s.; B. ss; B. s.; B. ss.; B.

1 Bell is struck at 12.30, and again at 4.30, 6.30, 8.30 p.m.; 12.30, 4.30, and 8.30 a.m.

2 Bells at 1 (struck with an interval of a second between each—B. s, B.), the same again at 5, 7, and 9 p.m.; 1, 5, and 9 a.m.

3 Bells at 1.30 (B. s, B. ss, B.), 5.30, 7.30, and 9.30 p.m.; 1.30, 5.30, and 9.30 a.m.

4 Bells at 2 (B. s, B. ss, B. s, B.), 6 and 10 p.m.; 2, 6, and 10 a.m.

5 Bells at 2.30 (B. s, B ss, B. s, B. ss, B.) and 10.30 p.m.; 2.30, 6.30, and 10.30 a.m.

6 Bells at 3 (B. s, B. ss, B. s, B. ss, B. s, B.) and 11 p.m.; 3, 7, and 11 a.m.

7 Bells at 3.30 (B. s, B. ss, B. s, B. ss, B. s, B. ss, B.) and 11.30 p.m.; 3.30, 7.30, and 11.30 a.m.

8 Bells (B. s, B. ss, B. s, B. ss, B. s, B. ss, B. s, B.) every 4 hours, at noon, at 4 p.m., 8 p.m., midnight, 4 a.m., and 8 a.m.

—*Whittaker's Almanac.*

## STONES: SPECIFIC GRAVITY, WEIGHT AND VOLUME.

| STONES. | Specific Gravity. | Weight of one Cubic Foot. | Cubic Feet per Ton. |
|---|---|---|---|
| | Water = 1. | Pounds. | Cubic Ft. |
| Alabaster, calcareous | 2.76 | 172.1 | 13.0 |
| " gypseous | 2.31 | 144.0 | 15.6 |
| Barytes | 4.45 | 277.5 | 8.07 |
| Basalt | 2.45–3.00 | 152.8–187.1 | 14.7–12.0 |
| Chalk, air-dried | 2.78 | 155 | 14.5 |
| Diamond | 3.50 | ..... | ..... |
| Flint | 2.59 | 164 | 13.7 |
| Felspar | 2.60 | 162.1 | 13.8 |
| Gneiss | 2.69 | 168 | 13.3 |
| Granite | 2.50–2.74 | 156–171 | 14.4–13.1 |
| Graphite | 2.20 | 137.2 | 16.3 |
| Jasper | 2.72 | 169.7 | 13.2 |
| Limestone | 1.86–2.53 | 116–158 | 19.3–14.2 |
| Marble: | | | |
| African | 2.80 | 174.6 | 12.8 |
| British | 2.71 | 169.0 | 13.3 |
| Carrara | 2.72 | 169.6 | 13.2 |
| Egyptian green | 2.67 | 166.5 | 13.5 |
| Florentine | 2.52 | 157.1 | 14.3 |
| French | 2.65 | 165.2 | 13.6 |
| Mica | 2.93 | 183 | 12.2 |
| Oolitic stones | 1.89–2.60 | 118–162 | 19.0–13.8 |
| Ores: | | | |
| Spicular or red iron ore | 5.21 | 327.4 | 6.84 |
| Magnetic iron ore | 5.09 | 317.6 | 7.05 |
| Brown iron ore | 3.92 | 244.6 | 9.16 |
| Spathic iron ore | 3.83 | 238.8 | 9.38 |
| Quartz | 2.61–2.71 | 162.8–169 | 13.8–13.3 |
| Sandstone | 2.04–2.70 | 127–168 | 17.6–13.3 |
| Serpentine | 2.81 | 175.2 | 12.8 |
| Slate | 2.60–2.85 | 162.1–177.7 | 13.8–12.6 |
| Talc, steatite | 2.70 | 168.4 | 13.3 |

MINERAL SUBSTANCES, VARIOUS: SPECIFIC GRAVITY, WEIGHT, AND VOLUME.

| Substances. | Specific Gravity. | Weight of One Cubic Foot. | Cubic Feet per Ton |
|---|---|---|---|
| | Water = 1. | Pounds. | Cubic Ft. |
| Alum | 1.72 | 107.2 | 20.9 |
| Ballast (brick rubbish and gravel) | 1.80 | 112 | 20.0 |
| Brick | 1.90–2.40 | 124.7–135.3 | 18.1–16.0 |
| Brickwork | 1.76–1.84 | 110 | 20.4–18 |
| Camphor | .99 | 61.7 | 36.3 |
| Clay | 1.92 | 119.7 | 18.7 |
| Coal: | | | |
| Anthracite | 1.37–1.59 | 85.4–99.1 | 26.2–22.6 |
| Bituminous | 1.20–1.31 | 74.8–81.7 | 30–28.1 |
| Earth, argillaceous: | ..... | 93–137 | 16–24 |
| Dry, loose | 1.15–1.29 | 72–80 | 31.1–28 |
| Dry, shaken | 1.32–1.48 | 82–92 | 27.3–24.3 |
| Moist, loose | 1.06–1.22 | 66–76 | 34.0–29.5 |
| Packed | 1.44–1.60 | 90–100 | 24.8–22.4 |
| Glass: | | | |
| Flint | 2.90 | 187.0 | 12.0 |
| Green | 2.70 | 168.4 | 13.3 |
| Plate | 2.70 | 168.4 | 13.3 |
| Thick flooring | 2.53 | 158.0 | 14.2 |
| Crown | 2.50 | 155.9 | 14.4 |
| Gunpowder, heaped | 1.75–1.84 | 109.1–114.7 | 20.5–19.5 |
| Ice, melting | .922 | 57.5 | 39 |
| Marl | 1.60–1.90 | 99.8–118.5 | 22.4–18.9 |
| Masonry: | | | |
| Ashlar granite | 2.37 | 147.5 | 15.2 |
| " Limestone, hard | 2.70 | 168.5 | 11.4 |
| " " semi-hard | 2.42 | 151.9 | 14.8 |
| " " soft | 2.34 | 145.6 | 15.4 |
| " Sandstone | 2.61 | 162.5 | 13.2 |
| Rubble, dry | 2.21 | 138 | 16.2 |
| " mortar | 2.47 | 154 | 14.6 |
| Mortar, hardened | 1.65 | 103 | 21.7 |
| Mud: | | | |
| Dry, close | 1.28–1.93 | 80–110 | 28.0–20.4 |
| Wet, moderately pressed | 1.93–2.09 | 110–130 | 20.4–17.2 |
| Wet, fluid | 1.67–1.92 | 104–120 | 21.5–18.7 |
| Phosphorus | 1.77 | 110.4 | 20.3 |
| Plaster | 1.87–2.47 | 98 | 22.9 |
| Portland cement | 1.25–1.51 | 78–94 | 28.7–23.8 |
| Potash | 2.10 | 131 | 17.1 |
| Sand | 1.44–1.87 | 90–117 | 24.9–19.1 |
| " saturated with water | 1.89–2.07 | 118–129 | 19–17.4 |
| Salt, common | 1.92 | 119.7 | 18.7 |
| " rock | 2.10–2.26 | 131–140.7 | 17.1–15.9 |
| Sulphur | 2.00 | 124.7 | 18.0 |
| Tiles | 2.00 | 124.7 | 18.0 |

## FUELS, ETC.: SPECIFIC GRAVITY, WEIGHT, AND BULK.

| Fuels. | Specific Gravity. | Weight of One Cubic Foot. | | Volume of One Ton, Heaped. |
|---|---|---|---|---|
| | | Solid. | Heaped. | |
| Coals. | Water = 1. | Lbs. | Lbs. | Cub. Ft. |
| Anthracite, American | 1.30–1.84 | 93.5 | 54.0 | ..... |
| Bituminous coal, American | 1.27 | 84.0 | 50.0 | ..... |
| Coke. | | | | |
| Coke, generally | ..... | 40–50 | 30.0 | 70–80 |
| American | ..... | ..... | 32.1 | 69.8 |
| Graphite | 2.33 | 145.3 | ..... | ..... |
| Lignite and Asphalt. | | | | |
| Perfect lignite | 1.29 | ..... | ..... | ..... |
| Imperfect lignite | 1.15 | ..... | ..... | ..... |
| Bituminous lignite | 1.18 | ..... | ..... | ..... |
| Asphalt | 1.06 | ..... | ..... | ..... |
| Wood Charcoal. | | | | |
| *As made, heaped.* | Heaped. | | | |
| Oak and beech | .24–.25 | ..... | 15–15.6 | ..... |
| Birch | .22–.23 | ..... | 13.7–14.3 | ..... |
| Pine | .20–.21 | ..... | 12.5–13.1 | ..... |
| Average | .225 | ..... | 14 | ..... |
| Gunpowder, loose | .90 | ..... | ..... | ..... |
| " shaken | 1.00 | ..... | ..... | ..... |
| " solid | 1.55–1.86 | ..... | ..... | ..... |

## WOODS: SPECIFIC GRAVITY AND WEIGHT.

| Wood. | Specific Gravity. | Weight of One Cubic Foot. |
|---|---|---|
| | Water = 1. | Pounds. |
| Ash | .84 | 52.4 |
| " with 20 per cent. moisture | .70 | 43.7 |
| Apple tree | .79 | 45.5 |
| Bamboo | .31–.40 | 19.5–24.9 |
| Beech | .75–.85 | 46.8–50.3 |
| " with 20 per cent. moisture | .82 | 51.1 |
| " cut one year | .66 | 41.2 |
| Birch | .72–.74 | 44.9–46.1 |
| Boxwood | 1.04 | 64.8 |
| Cedar of Lebanon | .49–.57 | 30.6–35.5 |
| Cork | .24 | 15.0 |
| Cypress, cut one year | .66 | 41.2 |
| Ebony | 1.13 | 70.5 |
| Elder pith | .076 | 4.74 |
| Elm | .55–.67 | 34.3 |
| " Green | .76 | 47.5 |
| " with 20 per cent. moisture | .72 | 44.9 |
| Fir, Norway Pine | .74 | 46.1 |
| " Spruce | .48–.70 | 29.9–43.7 |
| " Larch | .50–.64 | 31.2–39.9 |
| " White Pine, Scotch | .53 | 34.3 |
| " " " with 20 per cent. moisture | .49 | 30.6 |
| " Yellow Pine, American | .46 | 28.7 |
| " " " English | .66 | 41.2 |
| Lignum-Vitæ | .65–1.33 | 40.5–82.9 |
| Mahogany, Cuba | .56–1.06 | 34.9 |
| " Honduras | .56–1.06 | 34.9 |
| Maple | .65–.73 | 40.5 |
| " 20 per cent. moisture | .67 | 41.8 |
| Mulberry | .89 | 55.5 |
| Oak, American | .87 | 54.2 |
| Poplar | .39 | 24.3 |
| " White | .32–.51 | 20.0–31.8 |
| " 20 per cent. moisture | .48 | 29.9 |
| Rock-Elm | .80 | 50.0 |
| Sycamore | .59 | 36.8 |
| Walnut | .58 | 42.4 |
| Willow | .49 | 30.6 |

## ANIMAL SUBSTANCES: SPECIFIC GRAVITY AND WEIGHT. (Claudel.)

| Substance. | Specific Gravity. | Weight of One Cu. Ft. |
|---|---|---|
| | Water = 1. | Pounds. |
| Pearls | 2.72 | 169.6 |
| Coral | 2.69 | 167.7 |
| Ivory | 1.82–1.92 | 114–119.7 |
| Bone | 1.80–2.00 | 112.2–124.7 |
| Wool | 1.61 | 100.4 |
| Tendon | 1.12 | 69.8 |
| Cartilage | 1.09 | 68.0 |
| Human Body | 1.07 | 66.7 |
| Nerve | 1.04 | 64.9 |
| Beeswax | .96 | 59.9 |
| Lard | .95 | 59.3 |
| Spermaceti | .94 | 58.8 |
| White of Whalebone | .94 | 58.7 |
| Butter | .94 | 58.7 |
| Pork Fat | .94 | 58.7 |
| Tallow | .92 | 57.5 |
| Beef Fat | .92 | 57.5 |
| Mutton Fat | .92 | 57.4 |
| VEGETABLE SUBSTANCES:— | | |
| Cotton | 1.95 | 121.6 |
| Flax | 1.79 | 111.6 |
| Starch | 1.53 | 95.4 |
| Sugar | 1.005 | |
| Gutta-percha | .97 | 60.5 |
| India-rubber | .93 | 58.0 |
| | Weight of One Cu. Ft., loosely filled. | Weight of One Cu. Ft., closely filled. |
| Grain: | | |
| Wheat, California | 49 | 53 |
| Peas | 50 | 54 |
| Indian Corn | 43½ | 47 |

## LIQUIDS: SPECIFIC GRAVITY AND WEIGHT.

| Liquids at 32° F. | Specific Gravity. | Weight of One Cubic Foot. | Weight of One Br. Gallon. |
|---|---|---|---|
| | Water = 1. | Pounds. | Pounds. |
| Mercury | 13.596 | 848.7 | 136.0 |
| Sulphuric Acid, maximum concentration | 1.84 | 114.9 | 18.4 |
| Nitrous Acid | 1.55 | 96.8 | 15.5 |
| Chloroform | 1.53 | 95.5 | 15.3 |
| Nitric acid, of commerce | 1.22 | 76.2 | 12.2 |
| Acetic acid, maximum concentration | 1.08 | 67.4 | 10.8 |
| Milk | 1.03 | 64.3 | 10.3 |
| Sea Water, ordinary | 1.026 | 64.05 | 10.3 |
| Pure Water, at 39° F. | 1.000 | 62.425 | 10.0112 |
| Wine, Red | .99 | 62.0 | 9.9 |
| Oil, Linseed | .94 | 58.7 | 9.4 |
| " Rapeseed | .92 | 57.4 | 9.2 |
| " Whale | .92 | 57.4 | 9.2 |
| " Olive | .915 | 57.1 | 9.15 |
| " Turpentine | .87 | 54.3 | 8.7 |
| Tar | 1.00 | 62.4 | 10.0 |
| Petroleum | .88 | 54.9 | 8.8 |
| Naphtha | .85 | 53.1 | 8.5 |
| Ether, Nitric | 1.11 | 69.3 | 11.1 |
| " Sulphurous | 1.08 | 67.4 | 10.8 |
| " Nitrous | .89 | 55.6 | 8.9 |
| " Acetic | .89 | 55.6 | 8.9 |
| " Hydrochloric | .87 | 54.3 | 8.7 |
| " Sulphuric | .74 | 44.9 | 7.2 |
| Alcohol, proof spirit | .92 | 57.4 | 9.2 |
| " pure | .79 | 49.3 | 7.9 |
| Benzine | .85 | 53.1 | 8.5 |
| Proof Spirit | .80 | 49.9 | 8.0 |

## GASES AND VAPORS: SPECIFIC GRAVITY, WEIGHT, AND VOLUME.

| Gases at 32° F., and under one Atmosphere of Pressure. | Specific Gravity. | Weight of One Cubic Foot. | | Volume of One Pound Weight. |
|---|---|---|---|---|
| | Air = 1. | Pounds. | Ounces. | Cub. Ft. |
| Mercury | 6.9740 | .563 | 9.008 | 1.776 |
| Chloroform | 5.3000 | .428 | 6.846 | 2.337 |
| Turpentine | 4.6978 | .378 | 6.042 | 2.637 |
| Acetic Ether | 3.0400 | .245 | 3.927 | 4.075 |
| Benzine | 2.6943 | .217 | 3.480 | 4.598 |
| Sulphuric Ether | 2.5860 | .209 | 3.340 | 4.790 |
| Chlorine | 2.4400 | .197 | 3.152 | 5.077 |
| Sulphurous Acid | 2.2470 | .1814 | 2.902 | 5.513 |
| Alcohol | 1.6130 | .1302 | 2.083 | 7.679 |
| Carbonic Acid | 1.5290 | .12344 | 1.975 | 8.101 |
| Oxygen | 1.1056 | .089253 | 1.428 | 11.205 |
| Air | 1.0000 | .080728 | 1.29165 | 12.387 |
| Nitrogen | .9701 | .078596 | 1.258 | 12.723 |
| Carbonic Oxide | .9674 | .0781 | 1.250 | 12.804 |
| Olefiant Gas | .9847 | .0795 | 1.272 | 12.580 |
| Ammoniacal Gas | .5894 | .04758 | 7.613 | 21.017 |
| Light Carbureted Hydrogen | .5527 | .04462 | .7139 | 22.412 |
| Coal Gas | .4381 | .03536 | .5658 | 28.279 |
| Hydrogen | .0692 | .005592 | .0895 | 178.83 |

## WEIGHT AND VOLUME OF BODIES.
(Tod.)

| Bodies. | Weight of One Cubic Foot. | | Weight of One Cubic Inch. | Cubic Inches in One Pound. |
|---|---|---|---|---|
| Metals. | Oz. | Lb. | Oz. | Cub. In. |
| Antimony, cast | 6,702 | 418.8750 | 3.8748 | 3.8866 |
| Zinc, cast | 7,190 | 449.3750 | 4.1608 | 3.8431 |
| Iron, cast | 7,207 | 450.4375 | 4.1707 | 3.8364 |
| Tin, cast | 7,291 | 455.6875 | 4.2193 | 3.7920 |
| " hardened | 7,299 | 456.1875 | 4.2239 | 3.7878 |
| Pewter | 7,471 | 466.9375 | 4.3234 | 3.7007 |
| Iron, bar | 7,788 | 486.7500 | 4.5069 | 3.5500 |
| Cobalt, cast | 7,811 | 488.1875 | 4.5202 | 3.5396 |
| Steel, hard | 7,816 | 488.5000 | 4.5231 | 3.5373 |
| " soft meteoric | 7,833 | 489.5625 | 4.5329 | 3.5296 |
| Iron, hammered | 7,965 | 497.8125 | 4.6093 | 3.4792 |
| Nickel, cast | 8,279 | 517.4375 | 4.7910 | 3.3395 |
| Brass, cast | 8,395 | 524.6875 | 4.8582 | 3.2933 |
| " wire | 8,544 | 534.0000 | 4.9444 | 3.2359 |
| Nickel, hammered | 8,666 | 541.6250 | 5.0150 | 3.1903 |
| Gun-metal | 8,784 | 549.0000 | 5.0833 | 3.1476 |
| Copper, cast | 8,788 | 549.2500 | 5.0856 | 3.1461 |
| " wire | 8,878 | 554.8750 | 5.1377 | 3.1140 |
| " coin | 8,915 | 557.1875 | 5.1591 | 3.0959 |
| Bismuth, cast | 9,822 | 613.8750 | 5.6840 | 2.8149 |
| Silver, hammered | 10,510 | 656.8750 | 6.0821 | 2.6306 |
| " coin | 10,534 | 658.3750 | 6.0960 | 2.6246 |
| " pure, cast | 10,744 | 671.5000 | 6.2175 | 2.5733 |
| Rhodium | 11,000 | 687.5000 | 6.3657 | 2.5134 |
| Lead, cast | 11,352 | 709.5000 | 6.3694 | 2.4355 |
| Palladium | 11,800 | 737.5000 | 6.8287 | 2.5134 |
| Mercury (quicksilver) common | 13,568 | 848.0000 | 7.8518 | 2.0377 |
| " " pure | 14,000 | 875.0000 | 8.1018 | 1.9748 |
| Gold, trinket | 15,709 | 981.8125 | 9.0908 | 1.7600 |
| " coin | 17,647 | 1,102.9375 | 10.2123 | 1.6124 |
| " pure, cast | 19,258 | 1,203.6250 | 11.1446 | 1.4356 |
| " hammered | 19,316 | 1,210.0625 | 11.2042 | 1.4280 |
| Platinum, pure | 19,500 | 1,218.7500 | 11.2847 | 1.4178 |
| " hammered | 20,336 | 1,271.0000 | 11.7685 | 1.3595 |
| " wire | 21,041 | 1,315.0625 | 12.1765 | 1.3140 |
| " laminated | 22,069 | 1,379.3125 | 12.7714 | 1.2528 |
| Iridium, hammered | 23,000 | 1,437.5000 | 13.3101 | 1.2021 |

—Clark's Mechanical Engineer's Pocket Book.

## SPECIFIC GRAVITY.

Tables showing a comparison of the degrees of Baumé, Cartier, and Beck's Areometers, with specific gravity degrees.

### For Liquids Lighter than Water.

| Degrees of Baumé, Cartier, Beck. | Baumé. | Cartier. | Beck. |
|---|---|---|---|
| | Sp. Gr. | Sp. Gr. | Sp. Gr. |
| 0 | ..... | ..... | 1.0000 |
| 1 | ..... | ..... | 0.9941 |
| 2 | ..... | ..... | 0.9883 |
| 3 | ..... | ..... | 0.9826 |
| 4 | ..... | ..... | 0.9770 |
| 5 | ..... | ..... | 0.9714 |
| 6 | ..... | ..... | 0.9659 |
| 7 | ..... | ..... | 0.9604 |
| 8 | ..... | ..... | 0.9550 |
| 9 | ..... | ..... | 0.9497 |
| 10 | 1.000 | ..... | 0.9444 |
| 11 | 0.993 | 1.000 | 0.9392 |
| 12 | 0.986 | 0.992 | 0.9340 |
| 13 | 0.979 | 0.985 | 0.9289 |
| 14 | 0.973 | 0.977 | 0.9239 |
| 15 | 0.967 | 0.969 | 0.9189 |
| 16 | 0.960 | 0.962 | 0.9139 |
| 17 | 0.954 | 0.955 | 0.9090 |
| 18 | 0.948 | 0.948 | 0.9042 |
| 19 | 0.942 | 0.941 | 0.8994 |
| 20 | 0.935 | 0.934 | 0.8947 |
| 21 | 0.929 | 0.927 | 0.8900 |
| 22 | 0.924 | 0.920 | 0.8854 |
| 23 | 0.918 | 0.914 | 0.8808 |
| 24 | 0.912 | 0.908 | 0.8762 |
| 25 | 0.906 | 0.901 | 0.8717 |
| 26 | 0.901 | 0.895 | 0.8673 |
| 27 | 0.895 | 0.889 | 0.8629 |
| 28 | 0.889 | 0.883 | 0.8585 |
| 29 | 0.884 | 0.877 | 0.8542 |
| 30 | 0.879 | 0.871 | 0.8500 |
| 31 | 0.873 | 0.865 | 0.8457 |
| 32 | 0.868 | 0.859 | 0.8415 |
| 33 | 0.863 | 0.853 | 0.8374 |
| 34 | 0.858 | 0.848 | 0.8333 |
| 35 | 0.853 | 0.842 | 0.8292 |
| 36 | 0.848 | 0.837 | 0.8252 |
| 37 | 0.843 | 0.831 | 0.8212 |
| 38 | 0.838 | 0.826 | 0.8173 |
| 39 | 0.833 | 0.820 | 0.8133 |
| 40 | 0.829 | 0.815 | 0.8095 |
| 41 | 0.824 | 0.810 | 0.8061 |
| 42 | 0.819 | 0.805 | 0.8018 |
| 43 | 0.815 | 0.800 | 0.7981 |
| 44 | 0.810 | ..... | 0.7944 |
| 45 | 0.806 | ..... | 0.7907 |
| 46 | 0.801 | ..... | 0.7871 |
| 47 | 0.797 | ..... | 0.7834 |
| 48 | 0.792 | ..... | 0.7799 |
| 49 | 0.788 | ..... | 0.7763 |
| 50 | 0.784 | ..... | 0.7727 |
| 51 | 0.781 | ..... | 0.7692 |
| 52 | 0.776 | ..... | 0.7658 |
| 53 | 0.771 | ..... | 0.7623 |
| 54 | 0.769 | ..... | 0.7589 |
| 55 | 0.763 | ..... | 0.7556 |
| 56 | 0.759 | ..... | 0.7522 |
| 57 | 0.755 | ..... | 0.7489 |
| 58 | 0.751 | ..... | 0.7456 |
| 59 | 0.748 | ..... | 0.7423 |
| 60 | 0.744 | ..... | 0.7391 |
| 61 | 0.740 | ..... | 0.7359 |
| 62 | 0.736 | ..... | 0.7328 |

### For Liquids Heavier than Water.

| Degrees of Baumé, Beck. | Baumé. | Beck. |
|---|---|---|
| | Sp. Gr. | Sp. Gr. |
| 0 | 1.000 | 1.0000 |
| 1 | 1.007 | 1.0059 |
| 2 | 1.014 | 1.0119 |
| 3 | 1.020 | 1.0180 |
| 4 | 1.028 | 1.0241 |
| 5 | 1.034 | 1.0303 |
| 6 | 1.041 | 1.0366 |
| 7 | 1.049 | 1.0429 |
| 8 | 1.057 | 1.0494 |
| 9 | 1.064 | 1.0559 |
| 10 | 1.072 | 1.0625 |
| 11 | 1.080 | 1.0692 |
| 12 | 1.088 | 1.0759 |
| 13 | 1.096 | 1.0828 |
| 14 | 1.104 | 1.0897 |
| 15 | 1.113 | 1.0968 |
| 16 | 1.121 | 1.1039 |
| 17 | 1 130 | 1.1111 |
| 18 | 1.138 | 1.1184 |
| 19 | 1.147 | 1.1258 |
| 20 | 1.157 | 1.1333 |
| 21 | 1.166 | 1.1409 |
| 22 | 1.176 | 1.1486 |
| 23 | 1.185 | 1.1565 |
| 24 | 1.195 | 1.1644 |
| 25 | 1.205 | 1.1724 |
| 26 | 1.215 | 1.1806 |
| 27 | 1.225 | 1.1888 |
| 28 | 1.235 | 1.1972 |
| 29 | 1.245 | 1.2057 |
| 30 | 1.256 | 1.2143 |
| 31 | 1.267 | 1.2230 |
| 32 | 1.278 | 1.2319 |
| 33 | 1.289 | 1.2409 |
| 34 | 1.300 | 1.2500 |
| 35 | 1.312 | 1.2593 |
| 36 | 1.324 | 1.2680 |
| 37 | 1.337 | 1.2782 |
| 38 | 1.349 | 1.2879 |
| 39 | 1.361 | 1.2977 |
| 40 | 1.375 | 1.3077 |
| 41 | 1.388 | 1.3178 |
| 42 | 1.401 | 1.3281 |
| 43 | 1.414 | 1.3386 |
| 44 | 1.428 | 1.3492 |
| 45 | 1.442 | 1.3600 |
| 46 | 1.456 | 1.3710 |
| 47 | 1.470 | 1.3821 |
| 48 | 1.485 | 1.3934 |
| 49 | 1.500 | 1.4050 |
| 50 | 1.515 | 1.4167 |
| 51 | 1.531 | 1.4286 |
| 52 | 1.546 | 1.4407 |
| 53 | 1.562 | 1.4530 |
| 54 | 1.578 | 1.4655 |
| 55 | 1.596 | 1.4783 |
| 56 | 1.615 | 1.4912 |
| 57 | 1.634 | 1.5044 |
| 58 | 1.653 | 1.5179 |
| 59 | 1.671 | 1.5315 |
| 60 | 1.690 | 1.5454 |
| 61 | 1.709 | 1.5596 |
| 62 | 1.729 | 1.5741 |
| 63 | 1.750 | 1.5888 |
| 64 | 1.771 | 1.6038 |

## UNITS OF LOG MEASURE.

In the United States and Canada logs are most commonly measured in board feet. Firewood and wood cut into short bolts, such as small pulpwood, excelsior wood, etc., are usually measured in cords. In the Adirondack Mountains the 19-inch standard, or, as it is often called, "the market," is a common unit of log measure. In some localities a log 22 inches in diameter at the small end and 13 feet long is used as a standard log and is the unit for buying and selling timber. In other sections standards are used which are based on logs 12 feet long and respectively 21, 22, and 24 inches in diameter at the small end inside the bark.

In some cases logs are measured in cubic feet. This is common with long spar timber and with long logs to be cut or hewn square. In many localities timber is sold by the log or tree, and in some sections standing timber is sold for a specified amount per acre or other unit of land measure. Piles and mine props are usually sold by the piece or by the linear foot. Logs are occasionally sold by the ton.

## BOARD MEASURE.

The unit of board measure is the board foot, which is the contents of a board 1 foot square and 1 inch thick. The number of board feet which can be sawed from logs of different diameters and lengths is shown in log rules.

Logs are usually measured at the small end inside the bark, because the removal of the slabs reduces the logs to the dimensions of the small end. This is the custom in measuring short logs by all the rules which are used, except in certain cases. Some of the rules, for example the Doyle and the Partridge rules, were intended by their originators to be used for an average diameter, but most persons who use them take the diameter at the small end, except in case of long timber. In measuring long logs which are to be cut into short logs before being sawed into boards, the diameter is usually not taken at the small end alone. Thus in using the Maine Rule, long logs are scaled as two logs. The diameter at the small end inside the bark is measured and is taken as the diameter of the uppermost log. The diameter at the small end of the lower log is estimated by the log-scaler. Another method of measuring long logs, often used with the Doyle Rule, is to take the diameters at both ends inside the bark, average them, and use this average as the diameter of the log. Still another method in use is to take the diameter inside the bark, one-third the distance from the small end of the log.

Logs are usually cut from 2 to 6 inches longer than the standard lengths of boards, to allow for bruising in handling. This additional length is disregarded in scaling.

Log rules give the number of board feet in logs which are straight and sound. If logs are unsound or otherwise defective, a certain allowance must be made by the scaler. The determination of the amount in board feet which should be deducted for unsoundness or defects in a given log requires great skill on the part of the scaler, and, as it is a matter of judgment in each case, no definite directions can be given.

## CORD MEASURE.

Firewood, small pulpwood, and material cut into short sticks for excelsior, etc., is usually measured by the cord. A cord is 128 cubic feet of stacked wood. The wood is usually cut into 4-foot lengths, in which case a cord is a stack 4 feet high and 8 feet long. Sometimes, however, pulpwood is cut 5 feet long, and a stack of it 4 feet high and 8 feet long is considered 1 cord. In this case the cord contains 160 cubic feet of stacked wood. In localities where firewood is cut in 5-foot lengths a cord makes a stack 4 feet high and 6½ feet long, and contains 130 cubic feet of stacked wood. Where it is desirable to use shorter lengths for special purposes, the sticks are often cut 1½, 2, and even 3 feet long. A stack of such wood, 4 feet high and 8 feet long, is considered 1 cord, but the price is always made to conform to the shortness of the measure.

A cord foot is one-eighth of a cord. A cord foot is a stack of 4-foot wood 4 feet high and 1 foot long. Farmers frequently speak of a foot of cord wood, meaning a cord foot. By the expression "surface foot" is meant the number of square feet measured on the side of a stack.

In some localities, particularly in New England, cord wood is measured by means of calipers. Instead of stacking the wood and computing the cords in the ordinary way, the average diameter of each log is determined with calipers and the number of cords obtained by consulting a table which gives the amount of wood in logs of different diameters and lengths, expressed in so-called cylindrical feet. A cylindrical foot is one one-hundred and twenty-eighth of a cord. A better term would be "stacked cubic foot," as it represents a cubic foot of stacked wood, as opposed to a cubic foot of solid wood. The number of cylindrical or stacked cubic feet in a log is computed by squaring the average diameter of the log in inches, multiplying by the length of the log in feet, and dividing the result by 144.

Some tables give the results in feet and inches (cylindrical or stacked cubic, not linear feet).

A special caliper rule for measuring cord wood has been made by Mr. John Humphrey, of Keene, N. H. Instead of considering a cylindrical or stacked cubic foot equivalent to one one-hundred and twenty-eighth of a cord, he has assumed it to be equivalent to one one-hundredth of a cord. In either case the cylindrical or stacked cubic foot is a purely arbitrary unit and the final results in cords are the same.

The number of cylindrical or stacked cubic feet in the different logs is determined by means of calipers and reference to a table, or by means of the calipers alone if the results are inscribed directly upon them. The total number of cylindrical or stacked cubic feet is then divided by 128.

## CONVERSION OF CORD MEASURE INTO CUBIC MEASURE.

Dealers in wood frequently wish to convert cord measure into cubic measure, and vice versa. The converting factor used depends primarily on the form of the wood. If the wood is split, there is more solid contents in a stacked cord than if the wood is in

round sticks. There is more wood in a given stack if the sticks are smooth and straight than if they are rough and crooked. The converting factor depends, further, on the character of the stacking. If the wood is skillfully stacked there is more solid contents than when the work is poorly done. It has been found in Europe through a series of careful measurements that a stack of wood may be reduced to solid cubic measure by multiplying the number of cubic feet by the following factors:

For split firewood. . . . . 0.7
For small round firewood. . . . . .6

Thus, a cord of split firewood is equivalent to 128 cubic feet multiplied by 0.7, which equals 89.6 cubic feet. To convert a given number of cords into solid cubic feet, multiply by 128 and then multiply the product by 0.7 or 0.6, according as the wood is split or consists of small round sticks; or multiply directly by 89.6.

To convert a given number of solid cubic feet into cords, divide by 128 and then divide the result by 0.7 or 0.6, according to the form of the wood; or divide directly by 89.6. If the stacking is very poor or if the wood is rough and crooked, the figures must be modified.

No rule can be given for converting cord measure into board measure. Lumbermen assign to a cord of wood values varying from 500 to 1,000 board feet. So much depends upon the quality of the wood, the purpose for which it is to be used, the method of piling, etc., that no constant converting factor can be given.

Bark is piled in stacks and measured in the same way as firewood.

## CONVERSION OF CUBIC MEASURE INTO BOARD MEASURE.

The ratio between the number of board feet and cubic feet in logs depends on the species of tree, on the size of the logs, and on the method of scaling. The ratio for standing trees depends, further, on the minimum size of the merchantable log. For example, the ratio would be different, if 4 logs were cut from a tree, from the result if only 3 logs were taken. Satisfactory figures can, therefore, be obtained only by comparing the scales of logs and trees actually measured in the woods. Such tables are now being prepared by the Bureau of Forestry for different species in different regions.

## MEASUREMENT OF SAWED LUMBER—BOARD MEASURE.

The superficial measure of inch boards is obtained by multiplying the width in inches by the length in feet and dividing by 12. Tables showing the contents of boards of different widths and lengths are published in practically every lumberman's ready reckoner, of which there are many on the market.

The contents of boards thicker than 1 inch are obtained by multiplying the width in inches by the thickness in inches and the product by the length in feet, and then dividing by 12.—*The Woodman's Handbook.*

## HARDNESS OF MINERALS:

1. Talc.
2. Rock Salt. } Scratched by finger nail.
3. Calcite
4. Fluor
5. Apatite } Scratched by a knife blade.
6. Orthoclase
7. Quartz
8. Topaz
9. Corundum } May be roughly distinguished by a file.
10. Diamond

## HEAT—ITS MECHANICAL EQUIVALENT.

HEAT is a peculiar motion of the particles of matter which prevents their contact. Heat and mechanical power are convertible forms of energy. The energy of the heat that raises one pound of water 1° F. will lift a weight of 778 lbs. one foot. The power of a weight of 778 lbs. descending one foot, if applied to a small paddle wheel turning in one pound of water, will, by friction, raise the temperature of the water 1° F.

*A heat-unit* is the amount of heat that raises a pound of water 1° F., or that lifts a weight of 778 lbs. one foot.

*The mechanical equivalent* of a heat-unit is the power of a weight of 778 lbs. descending one foot, or of a one-pound weight descending 778 feet. Hence,

778 foot-pounds = 1 heat-unit.
1 heat-unit = 778 foot-pounds.

A galvanic battery that produces an electrical current capable of heating one pound of water 1° F., will yield magnetic force sufficient to raise a weight of 778 lbs. one foot high.

Thus heat, electricity, magnetism, and chemical force are brought into numerical correlation with mechanical power.

The illustrious philosopher, Dr. J. P. Joule, of Manchester, England, first measured accurately the mechanical equivalent of heat, A.D. 1845.

Heat of Metals.—A metal is an element possessing a luster, and the higher oxides of which only are acid-forming compounds. Metals have the following properties: A specific gravity usually greater than one. The specific heat is less than unity, and this heat varies inversely as the atomic weight of that element. The conductivity of the metals is greater than that of either the non-metals or their compounds.

The influence of heat upon metals is very varied; some melt at a low temperature, others require a red heat, a strong red, or a white heat respectively, to melt them. The following table, by Pouillet, will explain the temperatures corresponding to different colors:

| Heat Color. | Corresponds to | |
|---|---|---|
| Incipient red heat. . . . . | 525° C. | 977° F. |
| Dull red. . . . . | 700 | 1,292 |
| Incipient cherry red. . . | 800 | 1,472 |
| Cherry red. . . . . | 900 | 1,652 |
| Clear cherry red. . . . . | 1,000 | 1,832 |
| Deep orange. . . . . | 1,100 | 2,012 |
| Clear orange. . . . . | 1,200 | 2,192 |
| White. . . . . | 1,300 | 2,372 |
| Bright white. . . . . | 1,400 | 2,552 |
| Dazzling white. . . . . | 1,500 | 2,732 |

## STEAM PRESSURE AND TEMPERATURE.

| Pressure in Lbs. per Sq. In. | Corresponding Temperature, Fahrenheit. | Pressure in Lbs. per Sq. In. | Corresponding Temperature, Fahrenheit. | Pressure in Lbs. per Sq. In. | Corresponding Temperature, Fahrenheit. |
|---|---|---|---|---|---|
| 10 | 192.4 | 65 | 301.3 | 140 | 357.9 |
| 15 | 212.8 | 70 | 306.4 | 150 | 363.4 |
| 20 | 228.5 | 75 | 311.2 | 160 | 368.7 |
| 25 | 241.0 | 80 | 315.8 | 170 | 373.6 |
| 30 | 251.6 | 85 | 320.1 | 180 | 378.4 |
| 35 | 260.9 | 90 | 324.3 | 190 | 382.9 |
| 40 | 269.1 | 95 | 328.2 | 200 | 387.3 |
| 45 | 276.4 | 100 | 332.0 | 210 | 391.5 |
| 50 | 283.2 | 110 | 339.2 | 220 | 395.5 |
| 55 | 289.3 | 120 | 345.8 | 230 | 399.4 |
| 60 | 295.6 | 130 | 352.1 | 240 | 403.1 |

## TABLE OF TEMPERATURE.

| Degree of Fahr. | |
|---|---|
| 2,786 | Cast iron melts (Daniell). |
| 1,996 | Copper melts (Daniell). |
| 1,947 | Gold melts. |
| 1,873 | Silver melts (Daniell). |
| 1,750 | Brass (containing 25% of zinc) melts (Daniell). |
| 1,000 | Iron, bright cherry red (Poillet). |
| 980 | Red heat, visible in daylight (Daniell). |
| 941 | Zinc begins to burn (Daniell). |
| 773 | Zinc melts (Daniell). |
| 644 | Mercury boils (Daniell), 662 (Graham). |
| 640 | Sulphuric acid boils (Magrignac), 620 (Graham). |
| 630 | Whale oil boils (Graham). |
| 617 | Pure lead melts (Rudberg). |
| 600 | Linseed oil boils. |
| 518 | Bismuth melts (Gmelin). |
| 442 | Tin melts (Crichton). |
| 380 | Arsenious acid volatilizes. |
| 356 | Metallic arsenic sublimes. |
| 315 | Oil of turpentine boils (Kaure). |
| 302 | Etherification ends. |
| 257 | Saturated sol. of sal ammoniac boils (Taylor). |
| 256 | Saturated sol. of acetate of soda boils. |
| 239 | Sulphur melts (Miller), 226 (Fownes). |
| 238 | Saturated sol. of nitre boils. |
| 221 | Saturated sol. of salt boils (Paris Codex). |
| 220 | Saturated sol. of alum, carb. soda, and sulph. zinc, boil. |
| 218 | Saturated sol. of chlorate and prussiate potash, boil. |
| 216 | Saturated sol. of sulph. iron, sulph. copper, nitrate of lead, boil. |
| 214 | Saturated sol. of acetate lead, sulph. and bitartrate potash, boil. |
| 213 or (213.5) | Water begins to boil in glass. |
| 212 | Water boils in metal, barometer at 30°. |
| 211 | Alloy of 5 bismuth, 3 tin, 2 lead, melts. |
| 201 | Alloy of 8 bismuth, 5 lead, 3 tin, melts (Kane). |
| 207 | Sodium melts (Regnault). |
| 185 | Nitric acid 1.52 begins to boil. |
| 180 (about) | Starch forms a gelatinous compound with water. |
| 176 | Rectified spirit boils, benzol distils. |
| 173 | Alcohol (sp. gr. .796 to .800) boils. |
| 151 | Beeswax melts (Kane), 142 (Lepage). |
| 150 | Pyroxylic spirit boils (Scanlan). |
| 145 | White of egg begins to coagulate. |
| 141.8 | Chloroform, and ammonia of .945, boil. |
| 132 | Acetone (pyroacetic spirit) boils (Kane). |
| 122 | Mutton suet and styracin melt. |
| 116 | Bisulphuret of carbon boils (Graham). |
| 115 | Pure tallow melts (Lepage), 92 (Thomson). |
| 112 | Spermaceti and stearin of lard melt. |
| 111 | Phosphorus melts (Miller). |
| 98 | Temperature of the blood. |
| 95 | Ether (.720) boils. |
| 95 | Carbolic acid crystals become an oily liquid. |
| 88 | Acetous fermentation ceases, water boils *in vacuo*. |
| 77 | Vinous ferm. ends, acetous ferm. begins. |
| 64.4 | Oil of anise liquefies. |
| 59 | Gay Lussac's *Alcoomètre* graduated at. |
| 55 | Sirups to be kept at. |
| 30 (about) | Olive oil becomes partially solid. |
| 32 | Water freezes. |
| 5 | Cold produced by snow 2 parts and salt 1 part. |
| −37.9 | Mercury freezes. |

—*Cooley.*

## LINEAR EXPANSION OF SOLIDS AT ORDINARY TEMPERATURES.

| Substance. | For 1° Fahr. Length = 1. | For 1° Cent. Length = 1. |
|---|---|---|
| Aluminium (cast).... | .00001234 | .00002221 |
| Antimony (cryst.)... | .00000627 | .00001129 |
| Brass, cast..... | .00000957 | .00001722 |
| " English plate. | .00001052 | .00001894 |
| " sheet..... | .00001040 | .00001872 |
| Brick, best stock.... | .00000310 | .00000550 |
| Bronze (Baily's).... | | |
| Copper, 17..... | .00000986 | .00001774 |
| Tin, 2½..... | | |
| Zinc, 1..... | | |
| " ..... | .00000975 | .00001755 |
| Cement, Roman, dry. | .00000797 | .00001435 |
| Cement, Portland (mixed), pure..... | .00000594 | .00001070 |
| Cement, Portland, mortar, with sand.. | .00000656 | .00001180 |
| Concrete: cement mortar and pebbles | .00000795 | .00001430 |
| Copper..... | .00000887 | .00001596 |
| Ebonite..... | .00004278 | .00007700 |
| Glass, English flint.. | .00000451 | .00000812 |
| " French flint... | .00000484 | .00000872 |
| " white, free from lead.. | .00000492 | .00000886 |
| " blown..... | .00000498 | .00000896 |
| " thermometer .. | .00000499 | .00000897 |
| " hard..... | .00000397 | .00000714 |
| Granite, gray, dry... | .00000438 | .00000789 |
| " red " ... | .00000498 | .00000897 |
| Gold, pure..... | .00000786 | .00001415 |
| Iridium, pure..... | .00000356 | .00000641 |
| Iron, wrought..... | .00000648 | .00001166 |
| " Swedish..... | .00000636 | .00001145 |
| " cast..... | .00000556 | .00001001 |
| " soft..... | .00000626 | .00001126 |
| Lead..... | .00001571 | .00002828 |
| Marble, moist..... | .00000663 | .00001193 |
| " dry..... | .00000363 | .00000654 |
| " white Sicilian, dry... | .00000786 | .00001415 |
| Marble, black Galway | .00000308 | .00000554 |
| " Carrara..... | .00000471 | .00000848 |
| Masonry, of brick in cement mortar: headers..... | .00000494 | .00000890 |
| Masonry, of brick in cement mortar: stretchers..... | .00000256 | .00000460 |
| Mercury (cubic expansion)..... | .00009984 | .00017971 |
| Nickel..... | .00000695 | .00001251 |
| Osmium..... | .00000317 | .00000570 |
| Palladium, pure..... | .00000556 | .00001000 |
| Pewter..... | .00001129 | .00002033 |
| Plaster, white..... | .00000922 | .00001660 |
| Platinum..... | .00000479 | .00000863 |
| Platinum, 90 per cent. Iridium, 10 per cent..... hammered and annealed..... | .00000476 | .00000857 |
| Platinum, 85 per cent..... Iridium, 15 per cent..... | .00000453 | .00000815 |
| Porcelain..... | .00000200 | .00000360 |
| Quartz, parallel to major axis, $t$ 0° to 40° C..... | .00000434 | .00000781 |
| Quartz, perpendicular to major axis, $t$ 0° to 40° C..... | .00000788 | .00001419 |
| Quartz, cubic expansion at 16° C..... | .00001924 | .00003463 |
| Silver, pure..... | .00001079 | .00001943 |
| Slate..... | .00000577 | .00001038 |
| Steel, cast..... | .00000636 | .00001144 |
| " tempered..... | .00000689 | .00001240 |
| Stone (sandstone), dry..... | .00000652 | .00001174 |
| Stone (sandstone), Rauville..... | .00000417 | .00000750 |
| Stone (sandstone), Caen..... | .00000494 | .00000890 |
| Tin..... | .00001163 | .00002094 |
| Wedgwood ware..... | .00000489 | .00000881 |
| Wood, pine..... | .00000276 | .00000496 |
| Zinc..... | .00001407 | .00002532 |
| Zinc, 8..... | .00001496 | .00002692 |
| Tin, 1..... | | |

—Clark's Mechanical Engineer's Pocket Book.

## EXPANSION OF LIQUIDS.

The cubical expansion, or expansion of volume, of water, from 32° F. to 212° F. and upwards, is given in the following Table. The rate of expansion increases with the temperature. The expansion for the range of temperature from 32° to 212° is .0466, or fully 4½ per cent. of the volume at 32°; or an average of .000259 per degree, or $\frac{1}{3853}$ part of the volume at 32° F.

Expansion of Liquids from 32° to 212° F.
Volume at 32° = 1.

| Liquid. | Volume at 212°. | Expansion. |
|---|---|---|
| Alcohol..... | 1.1100 | $\frac{1}{9}$ |
| Nitric acid..... | 1.1100 | $\frac{1}{9}$ |
| Olive oil..... | 1.0800 | $\frac{1}{13}$ |
| Turpentine..... | 1.0700 | $\frac{1}{14}$ |
| Sea water..... | 1.0500 | $\frac{1}{20}$ |
| Water..... | 1.0466 | $\frac{1}{23}$ |
| Mercury..... | 1.018 | $\frac{1}{55}$ |

FRICTION.—The ratio obtained by dividing the entire force of friction by the normal pressure is called the coefficient of friction. The unit or coefficient of friction is the friction due to a normal pressure of one pound:

| | |
|---|---|
| Iron on oak..... | 0.62 |
| Cast iron on oak..... | 0.49 |
| Oak on oak, fibres parallel..... | 0.48 |
| Oak on oak, greased..... | 0.10 |
| Cast iron on cast iron..... | 0.15 |
| Wrought iron on wrought iron.. | 0.14 |
| Brass on iron..... | 0.16 |
| Brass on brass..... | 0.20 |
| Wrought iron on cast iron..... | 0.19 |
| Cast iron on elm..... | 0.19 |
| Soft limestone on the same..... | 0.64 |
| Hard limestone on the same.... | 0.38 |
| Leather belts on wooden pulleys. | 0.47 |
| Leather belts on cast-iron pulleys | 0.28 |
| Cast iron on cast iron, greased.. | 0.10 |

Pivots or axes of wrought or cast iron, on brass or cast-iron pillows:

| | |
|---|---|
| First, when constantly supplied with oil. | 0.05 |
| Second, when greased from time to time. | 0.08 |
| Third, without any application..... | 0.15 |

## STRENGTH OF MATERIALS.

### METALS.

| Name of Metal. | Tensile Strength in Pounds per Sq. In. |
|---|---|
| Aluminum wire | 30,000–40,000 |
| Brass wire, hard drawn | 50,000–150,000 |
| Bronze, phosphor, hard drawn | 110,000–140,000 |
| " silicon " " | 95,000–115,000 |
| Copper wire, hard drawn | 60,000–70,000 |
| Gold * wire | 38,000–41,000 |
| Iron, † cast | 13,000–29,000 |
| " wire, hard drawn | 80,000–120,000 |
| " " annealed | 50,000–60,000 |
| Lead, cast or drawn | 2,600–3,300 |
| Palladium * | 39,000 |
| Platinum * wire | 50,000 |
| Silver * wire | 42,000 |
| Steel, mild, hard drawn | 100,000–200,000 |
| " hard " " | 150,000–330,000 |
| Tin, cast or drawn | 4,000–5,000 |
| Zinc, cast | 7,000–13,000 |
| " drawn | 22,000–30,000 |

### STONES AND BRICKS.

| Name of Substance. | Resistance to Crushing in Pounds per Sq. In. |
|---|---|
| Basalt | 18,000–27,000 |
| Brick, soft | 300–1,500 |
| " hard | 1,500–5,000 |
| " vitrified | 9,000–26,000 |
| Granite | 17,000–26,000 |
| Limestone | 4,000–9,000 |
| Marble | 9,000–22,000 |
| Sandstone | 4,500–8,000 |
| Slate | 11,000–30,000 |

### TIMBER.

| Name of Wood | Tensile Strength in Pounds per Sq. In. | Resistance to Crushing in Pounds per Sq. In. |
|---|---|---|
| Ash | 11,000–21,000 | 6,000–9,000 |
| Beech | 11,000–18,000 | 9,000–10,000 |
| Birch | 12,000–18,000 | 5,000–7,000 |
| Chestnut | 10,000–13,000 | 4,000–6,000 |
| Elm | 12,000–18,000 | 6,000–10,000 |
| Hackberry | 10,000–16,000 | ..... |
| Hickory | 15,000–25,000 | 7,000–12,000 |
| Maple | 8,000–12,000 | 6,000–8,000 |
| Mulberry | 8,000–14,000 | ..... |
| Oak, burr | 15,000–20,000 | 7,000–10,000 |
| " red | 13,000–18,000 | 5,000–7,000 |
| " water | 12,000–16,000 | 4,000–6,000 |
| " white | 20,000–25,000 | 6,000–9,000 |
| Poplar | 10,000–15,000 | 5,000–8,000 |
| Walnut | 8,000–14,000 | 4,000–8,000 |

* On the authority of Wertheim.

† The crushing strength of cast iron is from 5.5 to 6.5 times the tensile strength.

NOTES.—According to Boys, quartz fibers have a tensile strength of between 116,000 and 167,000 pounds per square inch.

Leather belting of single thickness bears from 400 to 1,600 pounds per inch of its breadth. —*Smithsonian Tables.*

## WATER.

1 U. S. gallon equals 231 cubic inches; .1337 cubic foot; 8.333 pounds of water at 62° F.; 3.786 liters.

1 cubic inch of water at 62° F. equals .03608 pound; .5773 ounce; 252.6 grains; .004326 U. S. gallon; .01638 liter.

1 cubic foot of water at 62° F. equals 62.355 pounds; 997.68 ounces (about 1000); .557 cwt. (of 112 pounds); .0278 long ton; 7.4805 U. S. gallons; 28.315 liters; .02832 cubic meter.

1 cylindrical inch of water at 62° F. equals .02833 pound; .4533 ounce; .7854 cubic inch.

1 cylindrical foot of water at 62° F. equals 48.973 pounds (about 50); 783.57 ounces; .437 cwt. (of 112 pounds); .0219 long ton; 5.8758 U. S. gallons; 22.2380 liters; .02224 cubic meter.

1 cubic yard of water equals 1,684.8 pounds; 15.043 cwt. (of 112 pounds), or 15 cwt. 4.8 pounds; .7645 cubic meter.

1 liter of water equals 2.2046 pounds at 62° F.; .2641 U. S. gallon; 61.025 cubic inches; .0353 cubic foot.

1 cubic meter of water equals 1 metric ton, or 1,000 kilograms at 39.1° F. or 4° C.; 2,204.62 pounds at 39.1° F. or 4° C.; 2,203.7 pounds at 62.4 pounds per cubic foot; 1 ton of 2,240 pounds, nearly; 1 tun of 4 hogsheads, or 2,100 pounds, nearly; 264.2 U. S. gallons; 1.308 cubic yards; 35.3156 cubic feet; 1,000 liters.

The weight of fresh water is commonly assumed, in ordinary calculations, to be 62.4 pounds per cubic foot, which is the weight at 52.3° F. It is frequently taken as 62½ pounds or 1,000 ounces per cubic foot.

The volumes of given weights of water, at the rate of 62.4 pounds per cubic foot, are as follows:

1 ton (long), 35.90 cubic feet (about 36); 1 cwt. (of 112 pounds), 1.795 cubic feet; 1 pound, .016 cubic feet or 27.692 cubic inches; 1 ounce, 1.731 cubic inches; 1 metric ton, at 39.1° F. or 4° C., 35.3156 cubic feet; 1 kilogram, at 39.1° F. or 4° C., .0353 cubic feet or 61.025 cubic inches; 1 metric ton, at 52.3° F. (62.4 pounds per cubic foot), 35.330 cubic feet.

A pipe 1 yard in length holds about as many pounds of water at ordinary temperatures as the square of its diameter in inches (about two per cent. more).

A column of water at 62° F., 1 foot high, is equivalent to a pressure of .433 pound or 6.928 ounces per square inch of base; or to 62.355 pounds per square foot.

A column of water 1 inch high is equivalent to a pressure of .5773 ounce or .03608 pound per square inch; or to 5.196 pounds per square foot.

A column of water 100 feet high is equivalent to 43⅓ pounds per square inch; or 2.786 tons per square foot.

A column of water 1 mile deep, weighing 62.4 pounds per cubic foot, is equivalent to a pressure of about 1 ton per square inch.

1 pound per square inch is equivalent to a column of water at 62° F. 2.31 feet or 27.72 inches high.

## SEA WATER.

1 cubic foot at 62° F., 64 pounds; 1 cubic yard, 15½ cwt., nearly (8 pounds less); 1 cubic meter, 1 long ton, fully (20 pounds more); 1 ton, 35 cubic feet.

Ratio of weight of fresh water to that of sea water, 39 to 40, or 1 to 1.028.

## ICE AND SNOW.

1 cubic foot of ice at 32° F., 57.50 pounds; 1 pound of ice at 32° F., .0174 cubic foot, or 30.067 cubic inches; specific density of ice, .922; that of water at 62° F. being 1.

## AIR.

1 cubic foot, at 14.7 lbs. per square inch, or 1 atmosphere, equals .080728 lb. at 32° F.; 1.29 ounce at 32° F.; 565.1 grains at 32° F.; .076097 lb. at 62° F.; 1.217 ounce at 62° F.; 532.7 grains at 62° F.

1 liter, under 1 atmosphere, equals 1.293 grams at 32° F.; 19.955 grains at 32° F.

1 lb. of air at 62° F. equals 13.141 cubic feet.

The weights of equal volumes of mercury, water, and air, at 62° F. under 1 atmosphere, are as 11,140.56, 819.4, and 1.

1 atmosphere of pressure equals 14.7 lbs. per square inch; 2,116.4 lbs. per square foot; 1.0335 kilograms per square centimeter; 29.922 inches of mercury at 32° F.; 76 centimeters of mercury at 32° F.; 30 inches of mercury at 62° F.; 33.947 feet of water at 62° F.; 10.347 meters of water at 62° F.

1 lb. per square inch equals 2.035 inches of mercury at 32° F.; 51.7 millimeters of mercury at 32° F.; 2.04 inches of mercury at 62° F.; 2.31 feet of water at 62° F.; 27.72 inches of water at 62° F.

1 ounce per square inch equals 1.732 inches of water at 62° F.

1 lb. per square foot equals .1925 inch of water at 62° F.; .01417 inch of mercury at 62° F.

## STRENGTH OF ICE.

Ice 2 in. thick will bear infantry.

Ice 4 in. thick will bear cavalry or light guns.

Ice 6 in. thick will bear heavy field guns.

Ice 8 in. thick will bear 24-pounder guns on sledges; weight not over 1,000 lbs. to a square foot.

## WEIGHT OF BALLS.

$$W = \frac{D^3 + 00}{C};$$

$$D = \sqrt[3]{W \times C - 00}.$$

When $D$ = diameter of ball in inches;
$W$ = weight of ball in lbs.;
$C$ = a constant = 733 for cast iron;
= 464 for lead;
= 595 for copper;
= 635 for brass.

or,

$$W = D^3 \times C;$$

$$D = \sqrt[3]{W \times C}.$$

When $C$ = a constant = 0.1364 for cast iron;
= 0.2155 for lead;
= 0.168 for copper;
= 0.1574 for brass.

*Weight of cast-iron balls.*

$$W = \left(\frac{D}{2}\right)^3 \times 0.1.$$

*To find nominal horse-power of boiler required for direct-acting steam-pumps.*

$$NHP = \frac{D^2 - \text{the last figure}}{2}.$$

When $NHP$ = nominal horse-power;
$D$ = diameter of steam cylinder in inches.

## PIPES.

*Usual inclination of pipes.*

1 in. in 12 ft. = minimum fall for house drains;
1 " " 16 " = minimum fall for land drains;
1 " " 40 " = minimum fall for sub-drains for houses;
1 " " 100 " = minimum fall for main drains for houses;
1 " " 150 " = fall of mountain torrents;
1 " " 230 " = " " rivers and rapid currents;
1 " " 280 " = fall of strong currents;
1 " " 340 " = " " ordinary rivers with good current;
1 " " 440 " = fall of winding rivers subject to inundations with slow current;
1 " " 480 " = fall of water channels, supply pipes to reservoirs and small canals;
1 " " 570 " = fall of large canals;
1 " " 1,000 " = very slow current, approaching to stagnant water.

*Discharge through pipes.*

Discharge in 24 hours divided by 1,440 = discharge per min.; discharge in cubic feet per minute × 9,000 = imperial gallons per day of 24 hours; discharge in cubic feet per minute × 11,000 = U. S. gallons per day of 24 hours; discharge in cubic feet per second × 2.2 = cubic yards per minute; discharge in cubic feet per second × 6.24 = imperial gallons per second; discharge in cubic feet per second × 7.48 = U. S. gallons per second; discharge in cubic feet per second × 133 = cubic yards per hour; discharge in cubic feet per second × 375 = imperial gallons per minute; discharge in cubic feet per second × 450 = U. S. gallons per minute; discharge in cubic feet per second × 2,400 = long tons per day of 24 hours; discharge in cubic feet per second × 2,700 = short tons per day of 24 hours; velocity in feet per second × 0.68 = mile per hour; velocity in feet per second × 60 = feet per minute; velocity in feet per second × 20 = yards per minute; pressure head of water in feet = pressure of water in lbs. per square foot × 0.016; pressure of water in lbs. per square foot = head in feet × 62.32.

## ANIMAL POWER—HORSE.

A horse walking in a circle at a speed of 176 feet per minute will raise with a common deep-well pump—

4 h. per day 1,653 gals. per min.; 1 ft. high.
5 " " " 1,480 " " " " " "
6 " " " 1,350 " " " " " "
8 " " " 1,160 " " " " " "
10 " " " 1,040 " " " " " "

Tractive force of a horse when working 8 hours a day on a well-made road and walking at a rate of 2½ miles per hour, 150 lbs.

Tractive force of a horse when working a lift or horse-run with intervals of rest between each movement, the day's work not to exceed 6 hours, 300 lbs.

Tractive force of a horse when working in a circle of 30 feet diameter in working a mill for 8 hours per day at a pace of 2 miles per hour, 100 lbs.

A horse can exert a force horizontally at a dead pull, 400 lbs.

A horse can carry on his back a distance of 20 miles per day on a well-made road, without overexertion, from 250 to 300 lbs.

The horse-power adopted as a unit in estimating the force of a steam-engine = 33,000 lbs. raised 1 foot high in 1 minute, an amount of force which few horses could perform for any length of time.

MANUAL POWER.

Duration of work = 1 day of 8 to 10 hours.

| Description of Work | Mean Effect in Lbs. | Velocity in Feet per Minute. | Lbs. Raised 1 Foot High per Minute. |
|---|---|---|---|
| Lifting weights by hand breast high | 40 | 25 | 1,000 |
| Raising water from a well by a bucket and rope | 30 | 35 | 1,050 |
| Lifting a weight by a rope and overhead tackle | 40 | 30 | 1,200 |
| Working a hand pump | 30 | 60 | 1,800 |
| Drawing a canal boat | 12 | 160 | 1,920 |
| Working a ship's capstan | 25 | 100 | 2,500 |
| Turning the crank of a winch | 15 | 200 | 3,000 |
| Rowing a boat | 40 | 80 | 3,200 |

The efforts in the above table, although extending over 8 or 10 hours, exclusive of mealtimes, per day, are not altogether continuous, but include the usual intervals of rest or diminished exertion peculiar to each class of work.

WINDMILLS.

*To find the horse-power of a wind-engine.*

$$HP = \frac{A \times V^2}{1{,}100{,}000}.$$

When $HP$ = effective horse-power;
$A$ = area of sails in square feet;
$V$ = velocity of the wind in feet per second.

*To find the area of sails required for a given horse-power.*

$$A = \frac{HP \times 1{,}100{,}000}{V^2}.$$

The best effect is obtained when the total surface of the sails presented to the wind does not cover more than three-quarters of the surface of the whole disk described by the radial arms or whips.

*To find the force of wind.*

$P = 0.002288\ V^2$;
$P = 0.00422\ V_1{}^2$;
$P = 0.0023\ V^2 \times \sin X$.

When $P$ = pressure in lbs. per square foot;
$V$ = velocity in feet per second;
$V_1$ = velocity in miles per hour;
$X$ = angle of incidence of direction of the wind with the plane of the surface when it is oblique.

*To find the angle of the sails.*

$$a = 23° - \frac{18D^2}{R^2}.$$

When $a$ = angle of the sail with the plane of motion at any part of the sail;
$D$ = distance of any part of the sail from the axis in feet;
$R$ = total radius of sail in feet.

*To find angle of shaft with horizon.*

$a$ = 8 degrees on level ground;
= 15 degrees on high ground.

*To find breadth of whip.*

$B = \frac{1}{30}W$;
$D = \frac{1}{40}W$;
$B_1 = \frac{1}{60}W$;
$D_1 = \frac{1}{80}W$;
$W_1 = \frac{1}{3}W$.

When $W$ = length of whip in feet;
$W_1$ = width of sail in feet;
$B$ = breadth of whip at axis in feet;
$D$ = depth of whip at axis in feet;
$B_1$ = breadth of whip at tip in feet;
$D_1$ = depth of whip at tip in feet;

Divided by the whip in the proportion of 5 to 3, the narrow portion being nearest to the wind.

$W_{11} = \frac{5}{8}W$;
$D_{11} = \frac{5}{8}W$.

When $W_{11}$ = width of sail at axis;
$D_{11}$ = distance of sail from axis.

Cross-bars from 16 to 18 inches apart.

Velocity of tip of sails = 2.6 $V$, nearly.

In examining the ratio between the velocity of *the wind and the number of revolutions* of the wheel-shaft Mr. Smeaton obtained the result in table below, for Dutch sails, in their common position, when the radius of the wheel was 30 feet:

| Number of Revolutions of Wheel-shaft per Minute. | Velocity of Wind in an Hour. | Ratio between Velocity of the Wind and Revolutions of Wheel-shaft. |
|---|---|---|
| 3 | 2 miles | 0.666 |
| 5 | 4 " | 0.800 |
| 6 | 5 " | 0.833 |

*The most efficient angles.*

| Part of Radius which is Divided in Six Parts. | Angle with the Axis. | Angle of Weather. |
|---|---|---|
| 1 | 72° | 18° |
| 2 | 71° | 19° |
| 3 | 72° | 18° middle |
| 4 | 74° | 16° |
| 5 | 77½° | 12½° |
| 6 | 83° | 7° |

Supposing the radius of the sail to be 30 feet, then the sail will commence at ⅙th, or 5 feet from the axis, where the angle of inclination will be 72°, at ⅔ths or 10 feet from the axis will be 71°, and so on.

In order to utilize the maximum effect of wind, therefore, it is necessary to load the wind-engine so that the number of revolutions of the wheel is proportional to the velocity of the wind.

*To find proper number of revolutions of a wind-mill.*

$$N = \frac{3.16 \times V}{L \times \sin U};$$

if $U$ = 16°,

$$N = \frac{11.5\ V}{L};$$

When $N$ = number of revolutions of wheel per minute;
$V$ = velocity of the wind in feet per second;
$L = \sqrt{\frac{R^2 + R_1{}^2}{2}}$ = radius of center of percussion in feet;
$R$ = extreme radius of wheel in feet;
$R_1$ = inner radius of wheel in feet;
$U$ = mean angle of sails to the plane of motion.

## FORCE OF WIND WHEN BLOWING PERPENDICULARLY UPON A SURFACE OF ONE SQUARE FOOT.

| Velocity of Wind. | | | Perpendicular Force on One Square Foot in Lbs. | Description. |
|---|---|---|---|---|
| Miles per Hour. | Feet per Minute. | Feet per Second. | | |
| 1 | 88 | 1.47 | .005 | Hardly perceptible |
| 2 | 176 | 2.93 | .020 | Just perceptible |
| 3 | 264 | 4.40 | .044 | " |
| 4 | 352 | 5.87 | .079 | Gentle breeze |
| 5 | 440 | 7.33 | .123 | " " |
| 10 | 880 | 14.67 | .492 | Pleasant |
| 15 | 1,320 | 22.00 | 1.107 | " |
| 20 | 1,760 | 29.30 | 1.968 | Brisk gale |
| 25 | 2,200 | 36.60 | 3.075 | " " |
| 30 | 2,640 | 44.00 | 4.428 | High wind |
| 35 | 3,080 | 51.30 | 6.027 | " " |
| 40 | 3,520 | 58.60 | 7.872 | Very high wind |
| 45 | 3,960 | 66.00 | 9.963 | " " " |
| 50 | 4,400 | 73.30 | 12.300 | Storm |
| 60 | 5,280 | 88.00 | 17.712 | Great storm |
| 70 | 6,160 | 102.7 | 24.108 | " " |
| 80 | 7,040 | 117.3 | 31.488 | Hurricane |
| 100 | 8,800 | 146.6 | 49.200 | " |

—Whittaker's Mechanical Engineer's Pocket Book.

## METALS: WEIGHTS FOR VARIOUS DIMENSIONS.

| Metal. | Specific Weight. | Weight of One Cubic Foot. | Weight of One Square Foot. | | | Weight of One Linear Foot 1 In. Sq. | Weight of One Cubic Inch. |
|---|---|---|---|---|---|---|---|
| | | | 1 Inch Thick. | ½ Inch Thick. | ¹⁄₁₆ Inch Thick. | | |
| | Wrought Iron = 1. | Lbs. | Lbs. | Lbs. | Lbs. | Lbs. | Lbs. |
| Aluminum, wrought | .348 | 167 | 13.92 | 1.74 | 1.39 | 1.160 | .097 |
| " cast | .333 | 160 | 13.33 | 1.67 | 1.33 | 1.111 | .092 |
| Antimony | .879 | 418 | 34.83 | 4.35 | 3.48 | 2.902 | .242 |
| Bismuth | 1.285 | 617 | 51.42 | 6.42 | 5.14 | 4.283 | .357 |
| Brass, cast | 1.052 | 505 | 42.08 | 5.26 | 4.21 | 3.507 | .292 |
| " sheet | 1.098 | 527 | 43.92 | 5.49 | 4.39 | 3.652 | .304 |
| " yellow | 1.079 | 518 | 43.17 | 5.40 | 4.32 | 3.597 | .298 |
| " Muntz metal | 1.062 | 511 | 42.58 | 5.32 | 4.26 | 3.549 | .296 |
| " wire | 1.110 | 533 | 44.42 | 5.55 | 4.44 | 3.701 | .308 |
| Bronze, gun-metal | 1.106 | 531 | 44.25 | 5.54 | 4.43 | 3.688 | .307 |
| " mill bearings | 1.133 | 544 | 45.33 | 5.66 | 4.53 | 3.780 | .315 |
| " small bells | 1.004 | 482 | 40.17 | 5.04 | 4.02 | 3.347 | .279 |
| " speculum metal | .969 | 465 | 38.75 | 4.84 | 3.88 | 3.299 | .269 |
| Copper, sheet | 1.114 | 549 | 45.75 | 5.72 | 4.58 | 3.813 | .318 |
| " hammered | 1.158 | 556 | 46.33 | 5.79 | 4.63 | 3.861 | .322 |
| " wire | 1.154 | 554 | 46.17 | 5.77 | 4.62 | 3.778 | .315 |
| Gold | 2.500 | 1200 | 100.00 | 12.50 | 10.00 | 8.333 | .694 |
| Iron, cast | .937 | 450 | 37.50 | 4.69 | 3.75 | 3.125 | .260 |
| " wrought | 1.000 | 480 | 40.00 | 5.00 | 4.00 | 3.333 | .278 |
| Lead, sheet | 1.483 | 712 | 59.33 | 7.41 | 5.93 | 4.944 | .412 |
| Manganese | 1.040 | 499 | 41.58 | 5.20 | 4.16 | 3.465 | .289 |
| Mercury | 1.769 | 849 | 70.75 | 8.84 | 7.07 | 5.896 | .491 |
| Nickel, hammered | 1.127 | 541 | 45.08 | 5.64 | 4.51 | 3.757 | .313 |
| " cast | 1.075 | 516 | 43.00 | 5.37 | 4.30 | 3.583 | .299 |
| Platinum | 2.796 | 1342 | 111.83 | 13.97 | 11.18 | 9.320 | .777 |
| Silver | 1.365 | 655 | 54.58 | 6.82 | 5.46 | 4.549 | .379 |
| Steel | 1.020 | 490 | 40.83 | 5.12 | 4.10 | 3.403 | .284 |
| Tin | .962 | 462 | 38.50 | 4.81 | 3.85 | 3.208 | .268 |
| Zinc, sheet | .935 | 449 | 37.42 | 4.67 | 3.74 | 3.118 | .260 |
| " cast | .892 | 428 | 35.67 | 4.46 | 3.57 | 2.972 | .248 |

—Clark's Mechanical Engineer's Pocket Book.

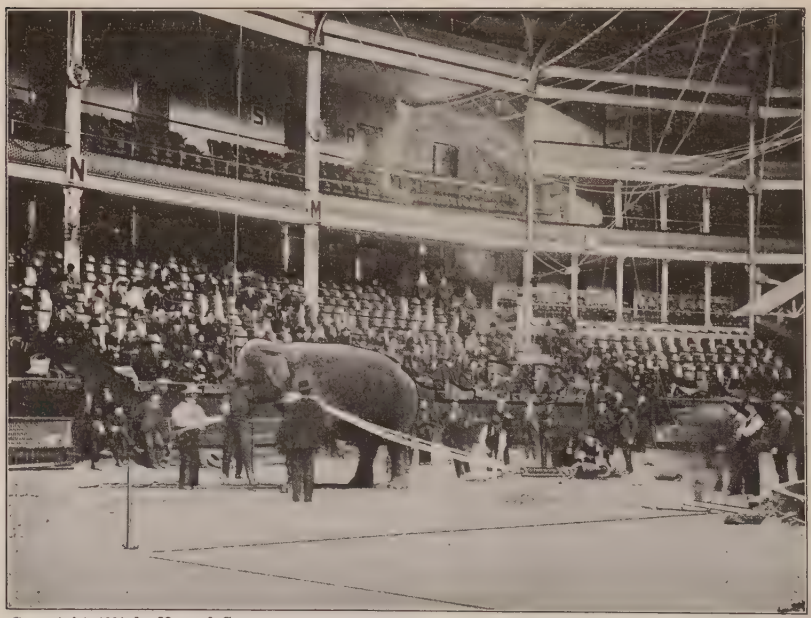
PROPORTIONATE WEIGHT OF CASTING TO WEIGHT OF WOOD PATTERN.

| A Pattern Weighing One Pound, Made of (less weight of core prints) | Cast Iron. | Brass. | Copper. | Bronze. | Bell Metal. | Zinc. |
|---|---|---|---|---|---|---|
| | Lbs. | Lbs. | Lbs. | Lbs. | Lbs. | Lbs. |
| Pine or fir will weigh in. | 14 | 15.8 | 16.7 | 16.3 | 17.1 | 13.5 |
| Oak " " " | 9 | 10.1 | 10.4 | 10.3 | 10.9 | 8.6 |
| Beech " " " | 9.7 | 10.9 | 11.4 | 11.3 | 11.9 | 9.1 |
| Linden " " " | 13.4 | 15.1 | 16.7 | 15.5 | 16.3 | 12.9 |
| Pear " " " | 10.2 | 11.5 | 11.9 | 11.8 | 12.4 | 9.8 |
| Birch " " " | 10 6 | 11.9 | 12.3 | 12.2 | 12.9 | 10.2 |
| Alder " " " | 12.8 | 14.3 | 14.9 | 14.7 | 15.5 | 12.2 |
| Mahogany " " " | 11.7 | 13.2 | 13.7 | 13.5 | 14.2 | 11.2 |
| Brass " " " | 0.84 | 0.95 | 0.99 | 0.98 | 1.0 | 0.81 |

PULLING STRENGTH OF MEN AND ANIMALS.

Compiled from a test made by Barnum & Bailey's Circus.

| Number. | Description. | Weight of Each in Lbs. | Total Pull in Lbs. | Pull per Unit. | Pull per Pound of Weight. |
|---|---|---|---|---|---|
| 2 | Horses. | 1,600 | 3,750 | 1,875 | 1.172 lbs. |
| 50 | Men. | 150 | 8,750 | 175 | 1.166 " |
| 100 | Men. | 150 | 12,000 | 120 | 0.8 " |
| 6 | Horses. | 1,800 | 8,875 | 1,479 | 0.822 " |
| 2 | Camels. | 1,800 | 2,750 | 1,375 | 0.764 " |
| 1 | Elephant. | 12,000 | 8,750 | 8,750 | 0.729 " |



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ELEPHANT, WEIGHING 12,000 POUNDS, ABOUT TO MAKE A PULL OF 8,750 POUNDS.

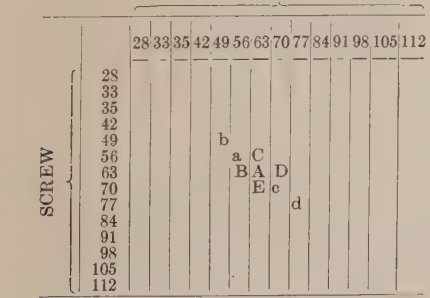
## BOILER TUBES.

The following table gives the draught area and heating surface of the various-sized boiler tubes and flues:

| External Diameter. | Draught Area in Square Inches. | Draught Area in Square Feet. | Outside Heating Surface in Feet per Foot of Tube in Length. | Number of Tubes in One Square Foot of Draught Area. |
|---|---|---|---|---|
| ⅜ | ..... | ..... | .1636 | ..... |
| ½ | ..... | ..... | .1963 | ..... |
| 1 | .575 | .0040 | .2618 | 250.0 |
| 1¼ | .968 | .0067 | .3272 | 149.3 |
| 1½ | 1.389 | .00964 | .3927 | 103.7 |
| 1¾ | 1.911 | .0133 | .4581 | 75.2 |
| 2 | 2.573 | .0179 | .5236 | 55.9 |
| 2¼ | 3.333 | .0231 | .5891 | 43.3 |
| 2½ | 4.083 | .0284 | .6545 | 35.2 |
| 2¾ | 5.027 | .0349 | .7200 | 28.7 |
| 3 | 6.070 | .0422 | .7854 | 23.7 |
| 3¼ | 7.116 | .0494 | .8508 | 20.2 |
| 3½ | 8.347 | .0580 | .9163 | 17.2 |
| 3¾ | 9.676 | .0672 | .9818 | 14.9 |
| 4 | 10.93 | .0759 | 1.0472 | 13.2 |
| 4¼ | 14.05 | .0996 | 1.1781 | 10.2 |
| 5 | 17.35 | .1205 | 1.3090 | 8.3 |
| 6 | 25.25 | .1753 | 1.5708 | 5.7 |
| 7 | 34.94 | .2426 | 1.8326 | 4.1 |
| 8 | 46.20 | .3208 | 2.0944 | 3.1 |
| 9 | 58.63 | .4072 | 2.3562 | 2.5 |
| 10 | 72.23 | .5016 | 2.6180 | 2.0 |

## TO OBTAIN INDEX OF A LATHE.

How to Obtain the Index of an Engine Lathe.—If you will note what thread the lathe will cut when two given gears are in place, you can easily construct a table that will show you just what thread any two gears will cause the lathe to cut. Suppose that two sixty-threes cause 12 threads to the inch. Then place 12 in the space A in the diagram below.




Now, 63 : 56 :: A : C } Direct proportion.
63 : 70 :: A : E }
Also, 56 : 63 :: A : B } Inverse proportion.
70 : 63 :: A : D }

The spaces may all be filled except a, b, c, d, etc., which it is useless to fill, as only your 63 gear is duplicated. A half-day's time will be sufficient for a good mathematician to fill out the table.

Nails, Memoranda Concerning.—This table will show at a glance the length of the various sizes, and the number of nails in a pound. They are rated from "3-penny" up to "20-penny." The first column gives the name, the second the length in inches, and the third the number per pound:

| | | |
|---|---|---|
| 3-penny, | 1 in. long, | 557 per lb. |
| 4-penny, | 1½ in. long, | 353 per lb. |
| 5-penny, | 1¾ in. long, | 232 per lb. |
| 6-penny, | 2 in. long, | 167 per lb. |
| 7-penny, | 2¼ in. long, | 141 per lb. |
| 8-penny, | 2½ in. long, | 101 per lb. |
| 10-penny, | 2¾ in. long, | 98 per lb. |
| 12-penny, | 3 in. long, | 54 per lb. |
| 20-penny, | 3½ in. long, | 34 per lb. |
| Spikes, | 4 in. long, | 16 per lb. |
| Spikes, | 4½ in. long, | 12 per lb. |
| Spikes, | 5 in. long, | 10 per lb. |
| Spikes, | 6 in. long, | 7 per lb. |
| Spikes, | 7 in. long, | 5 per lb. |

From this table an estimate of quantity and suitable sizes for any job can be easily made.

The relative adhesion of nails in the same wood, driven transversely and longitudinally, is as 100 to 78, or about 4 to 3 in dry elm, and 2 to 3 in deal.

Horse-power, very Rough Way of Estimating.—The power of a steam engine is calculated by multiplying together the area of the piston in inches, the mean steam pressure in pounds per square inch, the length of stroke in feet, and the number of strokes per minute, and dividing the product by 33,000. Or, multiply the square of the diameter of the cylinder in inches by 0.7854, and this product by the mean engine pressure, and the last product by the piston travel in feet per minute. Divide the last product by 33,000 for the indicated horse-power. In

the absence of logarithmic formulæ or expansion table, multiply the boiler pressure for ¼ cut-off by 0.91; for ½ cut-off by 0.85, ¾ cut-off by 0.75, ⅞ cut-off by 0.68. This will give the mean engine pressure per square inch near enough for ordinary practice, for steam pressures between 60 and 100 lbs., always remembering that the piston travel is twice the stroke multiplied by the number of revolutions per minute.

CASTINGS, CONTRACTION OF.—By Messrs. Bowen & Co., brass founders, London.

| | Inch. | Ins. of length. |
|---|---|---|
| In thin brass castings | ⅛ | in 9 |
| In thick " " | ⅛ | in 10 |
| In zinc castings | 5/32 | in 12 |
| In lead, according to purity | 3/32 to 5/32 | in 12 |
| In copper " " " | 3/32 to 5/32 | in 12 |
| In tin, " " " | 3/32 to 5/32 | in 12 |
| In silver, " " " | ⅛ | in 12 |
| In cast iron, according to purity, small castings | 1/10 | in 12 |
| In cast steel, according to purity, pipes | ⅛ | in 12 |

The above values fluctuate with the form of pattern, amount of ramming, and temperature of metal when poured. Green sand castings contract less than loam or dry sand castings.

GEARING, SIMPLE RULES ON.—The following rules will apply to both bevel and spur gears. When the term pitch is used, it always signifies diametrical, not circular pitch. For illustrations we will use gears having 64 teeth and 8 pitch.

*To Find Pitch Diameter.*—Divide the number of teeth by the pitch: 64÷8=8 in. pitch diameter.

*To Find Number of Teeth.*—Multiply the pitch diameter by the pitch: 8 in.×8=64, number of teeth.

*To Find the Pitch.*—Divide the number of teeth by the pitch diameter: 64÷8 in.=8, pitch.

*To Find Outside Diameter of Spur Wheels.*—Add 2 to the number of teeth and divide by the pitch: 64+2=66÷8=8¼ in. O. D.

*To Find Circular Pitch.*—Divide the decimal 3.1416 by the diametrical pitch: 3.1416 ÷8=0.3927 in.

*To Find the Distance between the Centers of Two Spur Gears.*—Divide half the sum of the teeth of both gears by the pitch: 64+64=128 ÷2=64÷8=8 in. centers.

PULLEYS, RULES FOR CALCULATING THE SPEED OF.—The diameter of the driven being given, to find its number of revolutions—

*Rule.*—Multiply the diameter of the driver by its number of revolutions, and divide the product by the diameter of the driven; the quotient will be the number of revolutions of the driven.

*Ex.*—Twenty-four in. diameter of driver ×150, number of revolutions, =3,600÷12 in. diameter of driven=300.

The diameter and revolutions of the driver being given, to find the diameter of the driven, that shall make any given number of revolutions in the same time.

*Rule.*—Multiply the diameter of the driver by its number of revolutions, and divide the product by the number of required revolutions of the driven; the quotient will be its diameter.

*Ex.*—Diameter of driver (as before) 24 in. ×revolutions 150=3,600. Number of revolutions of driven required=300. Then 3,600 ÷300=12 in.

The rules following are but changes of the same, and will be readily understood from the foregoing examples.

To ascertain the size of the driver:

*Rule.*—Multiply the diameter of the driven by the number of revolutions you wish to make, and divide the product by the required revolutions of the driver; the quotient will be the size of the driver.

To ascertain the size of pulleys for given speed:

*Rule.*—Multiply all the diameters of the drivers together and all the diameters of the driven together; divide the drivers by the driven; the answer multiply by the known revolutions of main shaft.

PAPER, WALL.—The following table from the *New York Newsdealer* shows how many rolls of wall-paper are required to cover a room of the dimensions indicated by the figures in the left-hand column, also the number of yards of border necessary:

| Size of Room. | Height of Ceiling. | Number of Doors. | Number of Windows. | Rolls of Paper. | Yards of Border. |
|---|---|---|---|---|---|
| 7×9 | 8 | 1 | 1 | 6 | 11 |
| 7×9 | 9 | 1 | 1 | 7 | 11 |
| 7×9 | 10 | 1 | 1 | 8 | 11 |
| 7×9 | 12 | 1 | 1 | 10 | 11 |
| 8×10 | 8 | 1 | 1 | 7 | 12 |
| 8×10 | 9 | 1 | 1 | 8 | 12 |
| 8×10 | 10 | 1 | 1 | 9 | 12 |
| 8×10 | 12 | 1 | 1 | 11 | 12 |
| 9×11 | 8 | 1 | 1 | 8 | 14 |
| 9×11 | 9 | 1 | 1 | 10 | 14 |
| 9×11 | 10 | 1 | 1 | 11 | 14 |
| 9×11 | 12 | 1 | 1 | 13 | 14 |
| 10×12 | 8 | 1 | 1 | 9 | 15 |
| 10×12 | 9 | 1 | 1 | 10 | 15 |
| 10×12 | 10 | 1 | 1 | 11 | 15 |
| 10×12 | 12 | 1 | 1 | 13 | 15 |
| 11×12 | 8 | 2 | 2 | 8 | 16 |
| 11×12 | 9 | 2 | 2 | 9 | 16 |
| 11×12 | 10 | 2 | 2 | 10 | 16 |
| 11×12 | 12 | 2 | 2 | 13 | 16 |
| 12×13 | 8 | 2 | 2 | 8 | 17 |
| 12×13 | 9 | 2 | 2 | 10 | 17 |
| 12×13 | 10 | 2 | 2 | 11 | 17 |
| 12×13 | 12 | 2 | 2 | 14 | 17 |
| 12×15 or 13×14 | 8 | 2 | 2 | 10 | 18 |
| 12×15 or 13×14 | 9 | 2 | 2 | 11 | 18 |
| 12×15 or 13×14 | 10 | 2 | 2 | 12 | 18 |
| 12×15 or 13×14 | 12 | 2 | 2 | 15 | 18 |
| 13×15 | 8 | 2 | 2 | 10 | 19 |
| 13×15 | 9 | 2 | 2 | 11 | 19 |
| 13×15 | 10 | 2 | 2 | 13 | 19 |
| 13×15 | 12 | 2 | 2 | 16 | 19 |
| 14×16 | 9 | 2 | 2 | 12 | 20 |
| 14×16 | 10 | 2 | 2 | 14 | 20 |
| 14×16 | 12 | 2 | 2 | 17 | 20 |
| 14×18 | 9 | 2 | 2 | 13 | 22 |
| 14×18 | 10 | 2 | 2 | 15 | 22 |
| 14×18 | 12 | 2 | 2 | 19 | 22 |
| 15×16 | 10 | 2 | 2 | 15 | 21 |
| 15×17 | 12 | 2 | 2 | 19 | 22 |

Deduct one-half roll of paper for each ordinary door or window extra—size 4×7 feet.

## UNITED STATES STANDARD GAUGE.

For Sheet and Plate Iron and Steel.

| Number of Gauge. | Thickness. | | Weight. | | Number of Gauge. |
|---|---|---|---|---|---|
| | Approximate Thickness in Fractions of an Inch. | Approximate Thickness in Decimal Parts of an Inch. | Weight per Square Foot in Ounces Avoirdupois. | Weight per Square Foot in Pounds Avoirdupois. | |
| 0000000 | 1–2 | .5 | 320 | 20. | 0000000 |
| 000000 | 15–32 | .46875 | 300 | 18.75 | 000000 |
| 00000 | 7–16 | .4375 | 280 | 17.5 | 00000 |
| 0000 | 13–32 | .40625 | 260 | 16.25 | 0000 |
| 000 | 3–8 | .375 | 240 | 15. | 000 |
| 00 | 11–32 | .34375 | 220 | 13.75 | 00 |
| 0 | 5–16 | .3125 | 200 | 12.5 | 0 |
| 1 | 9–32 | .28125 | 180 | 11.25 | 1 |
| 2 | 17–64 | .265625 | 170 | 10.625 | 2 |
| 3 | 1–4 | .25 | 160 | 10. | 3 |
| 4 | 15–64 | .234375 | 150 | 9.375 | 4 |
| 5 | 7–32 | .21875 | 140 | 8.75 | 5 |
| 6 | 13–64 | .203125 | 130 | 8.125 | 6 |
| 7 | 3–16 | .1875 | 120 | 7.5 | 7 |
| 8 | 11–64 | .171875 | 110 | 6.875 | 8 |
| 9 | 5–32 | .15625 | 100 | 6.25 | 9 |
| 10 | 9–64 | .140625 | 90 | 5.625 | 10 |
| 11 | 1–8 | .125 | 80 | 5. | 11 |
| 12 | 7–64 | .109375 | 70 | 4.375 | 12 |
| 13 | 3–32 | .09375 | 60 | 3.75 | 13 |
| 14 | 5–64 | .078125 | 50 | 3.125 | 14 |
| 15 | 9–128 | .0703125 | 45 | 2.8125 | 15 |
| 16 | 1–16 | .0625 | 40 | 2.5 | 16 |
| 17 | 9–160 | .05625 | 36 | 2.25 | 17 |
| 18 | 1–20 | .05 | 32 | 2.00 | 18 |
| 19 | 7–160 | .04375 | 28 | 1.75 | 19 |
| 20 | 3–80 | .0375 | 24 | 1.5 | 20 |
| 21 | 11–320 | .034375 | 22 | 1.375 | 21 |
| 22 | 1–32 | .03125 | 20 | 1.25 | 22 |
| 23 | 9–320 | .028125 | 18 | 1.125 | 23 |
| 24 | 1–40 | .025 | 16 | 1. | 24 |
| 25 | 7–320 | .021875 | 14 | .875 | 25 |
| 26 | 3–160 | .01875 | 12 | .75 | 26 |
| 27 | 11–640 | .0171875 | 11 | .6875 | 27 |
| 28 | 1–64 | .015625 | 10 | .625 | 28 |
| 29 | 9–640 | .0140625 | 9 | .5625 | 29 |
| 30 | 1–80 | .0125 | 8 | .5 | 30 |
| 31 | 7–640 | .0109375 | 7 | .4375 | 31 |
| 32 | 13–1280 | .01015625 | 6½ | .40625 | 32 |
| 33 | 3–320 | .009375 | 6 | .375 | 33 |
| 34 | 11–1280 | .00859375 | 5½ | .34375 | 34 |
| 35 | 5–640 | .0078125 | 5 | .3125 | 35 |
| 36 | 9–1280 | .00703125 | 4½ | .28125 | 36 |
| 37 | 17–2560 | .006640625 | 4¼ | .265625 | 37 |
| 38 | 1–160 | .00625 | 4 | .25 | 38 |

## ELECTRICAL ENGINEERING.

Units of Measurement.—The three most commonly used units are:

I. The unit of current, called the Ampere;
II. The unit of potential, called the Volt;
III. The unit of resistance, called the Ohm.

For some purposes these quantities are subdivided, thus in telegraphy the practical unit of current is the milli-ampere, *i.e.*, one-thousandth of an ampere. In some cases it is convenient to use multiples; insulation resistances are often expressed in terms of megohms, *i.e.*, a million ohms. The most commonly used multiples are the following:

1 Megohm $= 10^6$ ohms $= 1$ million ohms,
1 Microhm $= 10^{-6}$ ohm $= 1$ millionth of an ohm,
1 Kilowatt $= 10^3$ watts $= 1{,}000$ watts,
1 Micro-ampere $= 10^{-6}$ ampere $= 1$ millionth of an ampere.

Ohm's Law.—For steady currents the three quantities—current, potential, and resistance—are connected together by the relation discovered by Dr. Ohm, and called Ohm's Law. This law is stated thus

$$C = \frac{E}{R};$$

where $C$ = current (amperes);
$E$ = difference of potential (volts);
$R$ = resistance opposing the current (ohms).

All the units in scientific work are defined in terms of the fundamental units, which are

Unit of length = 1 centimeter.
" " mass = 1 gram.
" " time = 1 second.

These are spoken of as the C.G.S. units, and in the actual determination of a standard

ohm attempts have been made to obtain the scientific value as closely as possible. The first unit used as a standard was the British Association or B.A. unit coil. Messrs. Siemens also introduced a standard ohm, but both of these units differed from the true ohm as well as from each other. In order to avoid the consequent confusion, an international congress was held at Paris in 1893 to decide upon the standard values to be adopted.

### C. G. S. ELECTRICAL STANDARDS.

THE OHM is represented by the resistance offered by a column of mercury—at the temperature of melting ice—14.4521 grams in mass, of a constant cross-sectional area, and of a length of 106.3 centimeters.

THE AMPERE is represented by the unvarying electric current which, when passed through a solution of nitrate of silver in water, deposits silver at the rate of 0.001118 of a gram per second.

THE VOLT is the electrical pressure which, if steadily applied to a conductor whose resistance is 1 ohm, will produce a current of 1 ampere, and which is represented by 0.6974, or $\frac{1000}{1434}$ of the electrical pressure between the poles of the voltaic cell, known as Clark's cell, at a temperature of 15° C. (59° F.).

As in many of the older books and early papers dealing with electrical matters the older system of units is used, the following table will be useful for ascertaining the relative values of the quantities expressed:

| System. | True Ohm. | Legal Ohm. | B.A. Ohm. | Siemens Ohm. |
|---|---|---|---|---|
| True Ohm..... | 1.0000 | 1.0025 | 1.0138 | 1.0630 |
| Legal Ohm.... | 0.9975 | 1.0000 | 1.0113 | 1.0600 |
| B.A. Ohm..... | 0.9863 | 0.9889 | 1.0000 | 1.0482 |
| Siemens Ohm.. | 0.9.08 | 0.9434 | 0.9540 | 1.0000 |

UNIT OF QUANTITY.—The quantity of electricity that flows per second past a cross-section of a conductor carrying a current of one ampere is a Coulomb.

The practical unit is the quantity that flows per hour, and is measured in ampere-hours.

UNIT OF CAPACITY: THE FARAD.—The capacity of two conductors insulated from each other is the number of coulombs of electricity required to be given to one conductor, the other being supposed at zero potential, to produce a difference of pressure of 1 volt between the two. The unit of capacity is called a "farad," and two conductors arranged in a form known as a condenser of 1 farad capacity would be raised to a difference of pressure of 1 volt by a charge of 1 coulomb of electricity. The practical unit used, however, has a capacity one-millionth of a farad—*i.e.*, a microfarad.

JOULE.—When a power of one *watt* is being developed, the work done per second is sometimes called a "Joule." Hence, *one joule* equals 0.7375 foot-lb., and

1 watt-second = 1 joule.
1 watt-minute = 60 joules.
1 horse-power hour = 1,980,000 foot-lbs.
1 horse-power hour = 2,685,600 joules.
(*W. E. Ayrton.*)

WATT.—A "watt" is the power developed in a circuit when one ampere flows through it, and when the potential difference at its terminals is one volt; hence the number of watts developed in any circuit equals the product of the current in amperes flowing through it into the potential difference at its terminals in volts. Therefore

1 watt is the power developed when 44.25 foot-lbs. of work are done per minute.

1 watt is the power developed when 0.7375 foot-lb. of work is done per second.

1 watt equals $\frac{1}{746}$th of a horse-power.
(*W. E. Ayrton.*)

CALORIE.—The amount of heat required to raise 1 kilogram of water 1° C. is the unit of heat employed on the Continent.

1 calorie = 4,200 joules = $42 \times 10^9$ ergs.
1 joule = 0.000238 calories.

INDUCTION: THE HENRY.—The induction in a circuit when the difference of electrical pressure induced in the circuit is 1 volt, while the inducing current varies at the rate of 1 ampere per second, is called a "Henry."

### THE ELECTRO-MAGNETIC SYSTEM OF ELECTRIC UNITS.

UNIT OF CURRENT.—That current which, flowing in a conductor 1 centimeter long, and of 1 centimeter radius, produces at the center of the arc a magnetic field of unit strength.

This unit is ten times the ampere.

UNIT OF POTENTIAL.—Unit difference of potential exists between the ends of a conductor, when the expenditure of 1 erg per second will cause unit current to flow.

This E.M.F. is equal to one hundred-millionth of a volt.

*Note.*—The erg = work done by a force of 1 dyne through a distance of one centimeter = 0.001019 gramme—cent = 0.00000007386 foot-lb. (London).

UNIT OF RESISTANCE is that resistance which requires unit difference of potential to cause unit current to flow.

This resistance is 1,000-millionth of an ohm.

For ready reference the units most frequently used in practice are tabulated below, together with their value in C.G.S. absolute units.

| Electrical Quantity. | Name of Unit. | Dimensions of Unit. | Value in C.G.S. Units. |
|---|---|---|---|
| Resistance..... | Ohm..... | $LT^{-1}$ | $10^9$ C.G.S. units. |
| Current..... | Ampere..... | $L^{\frac{1}{2}}M^{\frac{1}{2}}T^{-1}$ | $10^{-1}$ " " |
| Electrical pressure..... | Volt..... | $L^{\frac{1}{2}}M^{\frac{1}{2}}T^{-2}$ | $10^8$ " " |
| Energy..... | Joule..... | $L^2MT^{-2}$ | $10^7$ " " |
| Capacity..... | Farad..... | $L^{-1}T^2$ | $10^{-9}$ " " |
| Capacity..... | Microfarad..... | ..... | $10^{-15}$ " " |
| Power..... | Watt..... | $L^2MT^{-3}$ | $10^7$ " " |
| Power..... | Kilowatt..... | ..... | $10^{10}$ " " |
| Work..... | Watt-hour..... | ..... | $10^9 \times 36$ " |
| Work..... | Kilowatt-hour..... | ..... | $10^{12} \times 36$ " |

## UNITS OF FORCE, PRESSURE, WORK, POWER.

FORCE.—1 *dyne* = that force which acting on 1 gramme for 1 second gives it a velocity of 1 centimeter per second (being absolute unit of force in the C.G.S. system, independent of local variations of gravity).

1 *gram weight* = at Paris, 980 dynes; at London, 981 dynes; at Glasgow, 982 dynes.

1 *pound weight* = 453.6 grams weight; = at Paris, 444,528 dynes; at London, 444,987 dynes.

PRESSURE.—1 *pound per square inch* = 0.0703 kilogram per square centimeter.

1 *kilogram per square centimeter* = 14.2 lbs. per square inch.

1 *atmosphere* = 30 in. of mercury = nearly 76 centimeters of mercury = nearly 15 lbs. per square inch = nearly 1,000,000 dynes per square centimeter.

The following will serve to illustrate the magnitude of some of these units:

10 ft. of pure copper wire 0.01 in. diameter is almost exactly equal to 1 ohm.

The current used in an ordinary incandescent lamp of 16 candle-power is about 0.6 ampere.

The electrical pressure of the terminals of the cell usually used for electric bells (Leclanche) is about 1.4 volt.

1 watt = about 44¼ foot-lbs. per minute.
746 watts = 1 horse-power.
1 kilowatt = about 1⅓ horse-power.

An easy way to convert watts into the equivalent horse-power is to mark off three places and add one-third: Thus,

What is the equivalent horse-power of 27,000 watts?

| | |
|---|---|
| Set off three decimal places | 27.000 |
| Add one-third | 9.000 |
| And the horse-power required = | 36 |

Find the equivalent number of watts of 48 electrical horse-power?

| | |
|---|---|
| Multiply the horse-power by 1,000, thus | |
| $48 \times 1{,}000$ | = 48,000 |
| Subtract one-quarter, $\frac{48{,}000}{4}$ | = 12,000 |
| And the required number of watts | = 36,000 |

## RESISTANCE.

CONDUCTORS.—Nearly all substances as they occur in nature conduct electricity—*i.e.*, if the substance is joined to a source of electrical energy, a magnetic field is created around it. Roughly, three groups of conductors may be formed, but of very varying degree: 1st, good conductors, pure metals, and alloys of metals; 2d, at a long interval, solutions of electrolytes—*i.e.*, solutions capable of being decomposed by the passage of an electric current through them; and 3d, very bad conductors, such as India rubber, ebonite, shellac, sulphur, glass, slate, marble, stoneware, mica, dry wood and paper, animal fibers (silk, wool, furs), petroleum oil, paraffin wax, ozokerit, pitch, bitumen, etc. Usually, in practical work, the first class is spoken of as conductors, and the third class as insulators.

RESISTANCE.—The resistance of a conductor is

(*a*) Directly proportional to its length; (*b*) Inversely proportional to its cross-sectional area; (*c*) Directly proportional to its specific resistance; (*d*) and usually increases with its temperature.

SPECIFIC RESISTANCE.—The specific resistance of a substance is usually stated as the resistance between the faces of a cube of the substance, 1 centimeter in length and 1 square centimeter in cross-sectional area.

The law of resistance may be stated thus, neglecting the effect of temperature:

$$R = \frac{\rho l}{s};$$

where
$R$ = the resistance in ohms;
$l$ = the length of conductor;
$s$ = the cross-sectional area of the conductor;
$\rho$ = the specific resistance of the material.

## RESISTANCE OF METALS AND ALLOYS (CHEMICALLY PURE) AT 32° F. IN STANDARD OHMS.

| Metal. | ($\rho$) Specific Resistance Cubic Centimeter Microhms. | Resistance per Foot, $\frac{1}{1000}$ Inch Diameter. | Resistance per Meter, 1 Millimeter Diameter. | Relative Resistance. |
|---|---|---|---|---|
| | | Ohms. | Ohms. | |
| Silver, annealed | 1.5006 | 9.0283 | 0.01911 | 1.000 |
| " hard-drawn | 1.6298 | 9.8028 | 0.02074 | 1.086 |
| Copper, annealed | 1.61966 | 10.2063 | 0.02160 | 1.130 |
| " hard-drawn | 1.73054 | 10.4117 | 0.02204 | 1.153 |
| Gold, annealed | 2.0531 | 12.3522 | 0.02614 | 1.369 |
| " hard-drawn | 2.0896 | 12.5692 | 0.0266 | 1.393 |
| Aluminum, annealed | 2.9055 | 17.4825 | 0.037 | 1.935 |
| Zinc, pressed | 5.6127 | 33.7614 | 0.071 | 3.741 |
| Platinum, annealed | 9.0352 | 54.3517 | 0.115 | 6.022 |
| Iron, annealed | 9.6933 | 58.308 | 0.123 | 6.460 |
| Lead, pressed | 19.584 | 117.79 | 0.249 | 13.05 |
| German silver, hard or annealed | 20.886 | 125.62 | 0.266 | 13.92 |
| Platinum, silver alloy (2 parts silver and 1 part platinum), hard or annealed | 24.329 | 146.36 | 0.310 | 16.21 |
| Manganese steel | 75 | 447.50 | 0.95 | 49.7 |
| Mercury | 96 | 570.84 | 1.208 | 62.73 |

## APPROXIMATE PERCENTAGE VARIATION IN RESISTANCE AT ABOUT 20° C. (68° F.)

| Metal or Alloy. | (a) Per 1° C. | (a) Per 1° F. |
|---|---|---|
| Platinum Silver (1 pt. Platinum to 2 pts. Silver), hard or annealed | 0.031 | 0.017 |
| German Silver, hard or annealed | 0.044 | 0.024 |
| Mercury | 0.072 | 0.040 |
| Bismuth, pressed | 0.354 | 0.197 |
| Gold, annealed | 0.365 | 0.203 |
| Zinc, pressed | 0.365 | 0.203 |
| Tin, " | 0.365 | 0.203 |
| Silver, annealed | 0.377 | 0.209 |
| Lead, pressed | 0.387 | 0.215 |
| Copper, annealed | 0.428 | 0.238 |
| Iron (about) | 0.5 | 0.278 |

—*Practical Engineer's Electrical Pocket-Book and Diary.*

## HEAT AND ELECTRICAL CONDUCTIVITY.

| Substances. | Heat Conductivity. | Electrical Conductivity. |
|---|---|---|
| Silver | 100.0 | 100.0 |
| Copper | 73.6 | 73.3 |
| Gold | 53.2 | 58.5 |
| Brass | 23.6 | 21.5 |
| Zinc | 19.9 | .... |
| Tin | 14.5 | 22.6 |
| Steel | 12.0 | .... |
| Iron | 11.9 | 13.0 |
| Lead | 8.5 | 10.7 |
| Platinum | 6.4 | 10.3 |
| Palladium | 6.3 | .... |
| Bismuth | 1.8 | 1.9 |

## RESISTANCE AND WEIGHT TABLE.

American gauge for cotton and silk-covered and bare copper wire.—The resistances are calculated for pure copper wire.

The number of feet to the pound is only approximate for insulated wire.

| No. | Diameter. | Feet per Pound. | | | Resistance, Naked Copper. | | | |
|---|---|---|---|---|---|---|---|---|
| | | Cotton Covered. | Silk Covered. | Naked. | Ohms per 1,000 Feet. | Ohms per Mile. | Feet per Ohm. | Ohms per Pound. |
| 8 | .12849 | ..... | ..... | 20 | .6259 | 3.3 | 1600 | .0125 |
| 9 | .11443 | ..... | ..... | 25 | .7892 | 4.1 | 1272 | .0197 |
| 10 | .10189 | ..... | ..... | 32 | .8441 | 4.4 | 1185 | .0270 |
| 11 | .09074 | ..... | ..... | 40 | 1.254 | 6.4 | 798 | .0501 |
| 12 | .08081 | 42 | 46 | 50 | 1.580 | 8.3 | 633 | .079 |
| 13 | .07196 | 55 | 60 | 64 | 1.995 | 10.4 | 504 | .127 |
| 14 | .06408 | 68 | 75 | 80 | 2.504 | 13.2 | 400 | .200 |
| 15 | .05707 | 87 | 95 | 101 | 3.172 | 16.7 | 316 | .320 |
| 16 | .05082 | 110 | 120 | 128 | 4.001 | 23 | 230 | .512 |
| 17 | .04525 | 140 | 150 | 161 | 5.04 | 26 | 198 | .811 |
| 18 | .0403 | 175 | 190 | 203 | 6.36 | 33 | 157 | 1.29 |
| 19 | .03539 | 220 | 240 | 256 | 8.25 | 43 | 121 | 2.11 |
| 20 | .03196 | 280 | 305 | 324 | 10.12 | 53 | 99 | 3.27 |
| 21 | .02846 | 360 | 390 | 408 | 12.76 | 68 | 76.5 | 5.20 |
| 22 | .02535 | 450 | 490 | 514 | 16.25 | 85 | 61.8 | 8.35 |
| 23 | .02257 | 560 | 615 | 649 | 20.30 | 108 | 48.9 | 13.3 |
| 24 | .0201 | 715 | 775 | 818 | 25.60 | 135 | 39.0 | 20.9 |
| 25 | .0179 | 910 | 990 | 1,030 | 32.2 | 170 | 31.0 | 33.2 |
| 26 | .01594 | 1,165 | 1,265 | 1,300 | 40.7 | 214 | 24.6 | 52.9 |
| 27 | .01419 | 1,445 | 1,570 | 1,640 | 51.3 | 270 | 19.5 | 84.2 |
| 28 | .01264 | 1,810 | 1,970 | 2,070 | 64.8 | 343 | 15.4 | 134 |
| 29 | .01126 | 2,280 | 2,480 | 2,617 | 81.6 | 432 | 12.2 | 213 |
| 30 | .01002 | 2,805 | 3,050 | 3,287 | 103 | 538 | 9.8 | 338 |
| 31 | .00893 | 3,605 | 3,920 | 4,144 | 130 | 685 | 7.7 | 539 |
| 32 | .00795 | 4,535 | 4,930 | 5,227 | 164 | 865 | 6.1 | 856 |
| 33 | .00708 | ..... | 6,200 | 6,590 | 206 | 1033 | 4.9 | 1357 |
| 34 | .0063 | ..... | 7,830 | 8,330 | 260 | 1389 | 3.8 | 2166 |
| 35 | .00561 | ..... | 9,830 | 10,460 | 328 | 1820 | 2.9 | 3521 |
| 36 | .005 | ..... | 12,420 | 13,210 | 414 | 2200 | 2.4 | 5469 |

## WEIGHT IN POUNDS PER MILE OF COPPER WIRE.

| Number. | Roebling. | Birmingham. | Brown & Sharpe. | English Legal Standard. | Number. | Roebling. | Birmingham. | Brown & Sharpe. | English Legal Standard. |
|---|---|---|---|---|---|---|---|---|---|
| 0000 | 2,466 | 3,286 | 3,375 | 2,555 | 14 | 102 | 110 | 65 | 102 |
| 000 | 2,092 | 2,884 | 2,677 | 2,210 | 15 | 83 | 83 | 52 | 83 |
| 00 | 1,750 | 2,305 | 2,123 | 1,933 | 16 | 64 | 68 | 41 | 65 |
| 0 | 1,504 | 1,846 | 1,684 | 1,682 | 17 | 47 | 53¾ | 33 | 50 |
| 1 | 1,278 | 1,437 | 1,335 | 1,437 | 18 | 35 | 38 | 26 | 37 |
| 2 | 1,104 | 1,287 | 1,058 | 1,216 | 19 | 27 | 28 | 20¾ | 26 |
| 3 | 950 | 1,071 | 839 | 1,012 | 20 | 19½ | 19¼ | 16¼ | 20¾ |
| 4 | 808 | 904 | 665 | 860 | 21 | 16¾ | 16¼ | 13 | 16¼ |
| 5 | 684 | 773 | 528 | 718 | 22 | 12¼ | 12¼ | 10¼ | 12½ |
| 6 | 588 | 657 | 418 | 588 | 23 | 10¼ | 10¼ | 8¼ | 9¼ |
| 7 | 500 | 517 | 332 | 495 | 24 | 8¼ | 7¾ | 6¼ | 7¾ |
| 8 | 419 | 435 | 263 | 409 | 25 | 6¼ | 6¼ | 5¼ | 6½ |
| 9 | 350 | 350 | 209 | 332 | 26 | 5 | 5 | 4 | 5 |
| 10 | 291 | 287 | 166 | 263 | 27 | 4½ | 4 | 3½ | 4 |
| 11 | 230 | 230 | 131 | 215 | 28 | 4 | 3½ | 2½ | 3½ |
| 12 | 176 | 190 | 104 | 173 | 29 | 3⅝ | 2⅝ | 2 | 3 |
| 13 | 135 | 144 | 83 | 135 | 30 | 3¼ | 2¼ | 1⅝ | 2½ |

## WIRE GAUGES, IN DECIMAL PARTS OF AN INCH.

| Number of Wire Gauge. | Roebling. | Brown & Sharpe. | Birmingham or Stubs. | English Legal Standard. | Old English, or London. |
|---|---|---|---|---|---|
| 000000 | 0.46 | ..... | ..... | 0.464 | ..... |
| 00000 | 0.43 | ..... | ..... | 0.432 | ..... |
| 0000 | 0.393 | 0.46 | 0.454 | 0.4 | 0.454 |
| 000 | 0.362 | 0.40964 | 0.425 | 0.372 | 0.425 |
| 00 | 0.331 | 0.3648 | 0.380 | 0.348 | 0.38 |
| 0 | 0.307 | 0.32495 | 0.340 | 0.324 | 0.34 |
| 1 | 0.283 | 0.2893 | 0.3 | 0.3 | 0.3 |
| 2 | 0.263 | 0.25763 | 0.284 | 0.276 | 0.284 |
| 3 | 0.244 | 0.22942 | 0.259 | 0.252 | 0.259 |
| 4 | 0.225 | 0.20431 | 0.238 | 0.232 | 0.238 |
| 5 | 0.207 | 0.18194 | 0.22 | 0.212 | 0.22 |
| 6 | 0.192 | 0.16202 | 0.203 | 0.192 | 0.203 |
| 7 | 0.177 | 0.14428 | 0.18 | 0.176 | 0.18 |
| 8 | 0.162 | 0.12849 | 0.165 | 0.16 | 0.165 |
| 9 | 0.148 | 0.11443 | 0.148 | 0.144 | .148 |
| 10 | 0.135 | 0.10189 | 0.134 | 0.128 | 0.134 |
| 11 | 0.12 | 0.09074 | 0.12 | 0.116 | 0.12 |
| 12 | 0.105 | 0.08081 | 0.109 | 0.104 | 0.109 |
| 13 | 0.092 | 0.07196 | 0.095 | 0.092 | 0.095 |
| 14 | 0.08 | 0.06408 | 0.083 | 0.08 | 0.083 |
| 15 | 0.072 | 0.05706 | 0.072 | 0.072 | 0.072 |
| 16 | 0.063 | 0.05082 | 0.065 | 0.064 | 0.065 |
| 17 | 0.054 | 0.04525 | 0.058 | 0.056 | 0.058 |
| 18 | 0.047 | 0.0403 | 0.049 | 0.048 | 0.049 |
| 19 | 0.041 | 0.03589 | 0.042 | 0.04 | 0.04 |
| 20 | 0.035 | 0.03196 | 0.035 | 0.036 | 0.035 |
| 21 | 0.032 | 0.02846 | 0.032 | 0.032 | 0.0315 |
| 22 | 0.028 | 0.02534 | 0.028 | 0.028 | 0.0295 |
| 23 | 0.025 | 0.02257 | 0.025 | 0.024 | 0.027 |
| 24 | 0.023 | 0.0201 | 0.022 | 0.022 | 0.025 |
| 25 | 0.02 | 0.0179 | 0.02 | 0.02 | 0.023 |
| 26 | 0.018 | 0.01594 | 0.018 | 0.018 | 0.0205 |
| 27 | 0.017 | 0.01419 | 0.016 | 0.0164 | 0.01875 |
| 28 | 0.016 | 0.01264 | 0.014 | 0.0148 | 0.0165 |
| 29 | 0.015 | 0.01125 | 0.013 | 0.0136 | 0.0155 |
| 30 | 0.014 | 0 01002 | 0.012 | 0.0124 | 0.01375 |
| 31 | 0.0135 | 0.00893 | 0.010 | 0.0116 | 0.01225 |
| 32 | 0.013 | 0.00795 | 0.009 | 0.0108 | 0.01125 |
| 33 | 0.011 | 0.00708 | 0.008 | 0.01 | 0.01025 |
| 34 | 0.01 | 0.0063 | 0.007 | 0.0092 | 0.0095 |
| 35 | 0.0095 | 0.00561 | 0.005 | 0.0084 | 0.009 |
| 36 | 0.009 | 0.005 | 0.004 | 0.0076 | 0.0075 |

## TABLE INDICATING SIZE, WEIGHT, AND LENGTH OF IRON AND STEEL WIRE.

| Gauge Numbers. | Diameter, Ins. | W'ight of 100 Feet. Lbs. | W'ight of One Mile, Lbs. | Feet in 2000 Lbs. | Area, Square Ins. |
|---|---|---|---|---|---|
| 3–0 | .362 | 34.73 | 1834 | 5,759 | .102921 |
| 2–0 | .331 | 29.04 | 1533 | 6,886 | .086049 |
| 1–0 | .307 | 25.00 | 1318 | 8,000 | .074023 |
| 1 | .283 | 21.23 | 1121 | 9,425 | .062901 |
| 2 | .263 | 18.34 | 968 | 10,905 | .054325 |
| 3 | .244 | 15.78 | 833 | 12,674 | .046759 |
| 4 | .225 | 13.39 | 707 | 14,936 | .039760 |
| 5 | .207 | 11.35 | 599 | 17,621 | .033653 |
| 6 | .192 | 9.73 | 514 | 20,555 | .028952 |
| 7 | .177 | 8.30 | 439 | 24,906 | .024605 |
| 8 | .162 | 6.96 | 367 | 28,734 | .020612 |
| 9 | .148 | 5.80 | 306 | 34,483 | .017203 |
| 10 | .135 | 4.83 | 255 | 41,408 | .014313 |
| 11 | .120 | 3.82 | 202 | 52,356 | .011309 |
| 12 | .105 | 2.92 | 154 | 68,493 | .008659 |
| 13 | .092 | 2.24 | 118 | 89,286 | .006647 |
| 14 | .080 | 1.69 | 89 | 118,343 | .005026 |
| 15 | .072 | 1.37 | 72 | 145,985 | .004071 |
| 16 | .063 | 1.05 | 55 | 190,476 | .003117 |
| 17 | .054 | 0.77 | 41 | 259,740 | .002290 |
| 18 | .047 | 0.58 | 31 | 344,827 | .001734 |
| 19 | .041 | 0.45 | 24 | 444,444 | .001320 |
| 20 | .035 | 0.32 | 17 | 625,000 | .000962 |
| 21 | .032 | 0.27 | 14 | 740,741 | .000804 |
| 22 | .028 | 0.21 | 11 | 952,381 | .000615 |
| 23 | .025 | 0.175 | 9.24 | ..... | .000491 |
| 24 | .023 | 0.140 | 7.39 | ..... | .000415 |
| 25 | .020 | 0.116 | 6.124 | ..... | .000314 |
| 26 | .018 | 0.093 | 4.91 | ..... | .000254 |
| 27 | .017 | 0.083 | 4.382 | ..... | .000227 |
| 28 | .016 | 0.074 | 3.907 | ..... | .000201 |
| 29 | .015 | 0.061 | 3.22 | ..... | .000176 |
| 30 | .014 | 0.054 | 2.851 | ..... | .000154 |
| 31 | .0135 | 0.050 | 2.64 | ..... | .000143 |
| 32 | .013 | 0.046 | 2.428 | ..... | .000132 |
| 33 | .011 | 0.037 | 1.953 | ..... | .000095 |
| 34 | .010 | 0.030 | 1.584 | ..... | .000078 |
| 35 | .0095 | 0.025 | 1.32 | ..... | .000071 |
| 36 | .009 | 0.021 | 1.161 | ..... | .000064 |

## ELECTRICAL HORSE-POWER.

Calculated from $\frac{E \times C}{746}$.

| Current in Amperes. | E.M.F. in Volts. | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 | 110 | 120 | 130 | 140 | 150 |
| 5 | 0.06 | 0.13 | 0.20 | 0.28 | 0.33 | 0.40 | 0.47 | 0.53 | 0.60 | 0.67 | 0.73 | 0.80 | 0.87 | 0.93 | 1.0 |
| 10 | 0.13 | 0.28 | 0.40 | 0.53 | 0.67 | 0.80 | 0.93 | 1.07 | 1.2 | 1.3 | 1.4 | 1.6 | 1.6 | 1.9 | 2.0 |
| 20 | 0.28 | 0.53 | 0.80 | 1.07 | 1.3 | 1.6 | 1.9 | 2.1 | 2.4 | 2.7 | 2.9 | 3.2 | 3.5 | 3.7 | 4.0 |
| 30 | 0.40 | 0.80 | 1.2 | 1.6 | 2.0 | 2.4 | 2.8 | 3.2 | 3.6 | 4.0 | 4.4 | 4.8 | 5.2 | 5.6 | 6.0 |
| 40 | 0.53 | 1.07 | 1.6 | 2.1 | 2.6 | 3.2 | 3.7 | 4.2 | 4.8 | 5.3 | 5.9 | 6.4 | 6.9 | 7.5 | 8.0 |
| 50 | 0.67 | 1.30 | 2.0 | 2.6 | 3.3 | 4.0 | 4.6 | 5.4 | 6.0 | 6.7 | 7.4 | 8.0 | 8.7 | 9.4 | 10.0 |
| 60 | 0.80 | 1.6 | 2.4 | 3.2 | 4.0 | 4.8 | 5.6 | 6.4 | 7.2 | 8.0 | 8.8 | 9.6 | 10.4 | 11.2 | 12.0 |
| 70 | 0.93 | 1.9 | 2.8 | 3.7 | 4.6 | 5.6 | 6.5 | 7.5 | 8.4 | 9.4 | 10.3 | 11.2 | 12.3 | 13.1 | 14.0 |
| 80 | 1.07 | 2.1 | 3.2 | 4.2 | 5.4 | 6.4 | 7.5 | 8.5 | 9.6 | 10.7 | 11.8 | 12.8 | 13.9 | 15.0 | 16.0 |
| 90 | 1.2 | 2.4 | 3.6 | 4.8 | 6.0 | 7.2 | 8.4 | 9.6 | 10.8 | 12.0 | 13.2 | 14.4 | 15.6 | 16.9 | 18.0 |
| 100 | 1.3 | 2.7 | 4.0 | 5.3 | 6.7 | 8.0 | 9.4 | 10.7 | 12.0 | 13.4 | 14.7 | 16.0 | 17.4 | 18.7 | 20.0 |
| 110 | 1.4 | 2.9 | 4.4 | 5.9 | 7.4 | 8.8 | 10.3 | 11.8 | 13.2 | 14.7 | 16.2 | 17.6 | 19.1 | 20.6 | 22.0 |
| 120 | 1.5 | 3.2 | 4.8 | 6.4 | 8.0 | 9.6 | 11.2 | 12.8 | 14.4 | 16.0 | 17.6 | 19.2 | 20.9 | 22.5 | 24.0 |
| 130 | 1.6 | 3.5 | 5.2 | 6.9 | 8.7 | 10.4 | 12.3 | 13.9 | 15.6 | 17.4 | 19.1 | 20.9 | 22.6 | 24.4 | 26.0 |
| 140 | 1.9 | 3.7 | 5.6 | 7.5 | 9.4 | 11.2 | 13.1 | 15.0 | 16.9 | 18.7 | 20.6 | 22.5 | 24.4 | 26.2 | 28.0 |
| 150 | 2.0 | 4.0 | 6.0 | 8.0 | 10.0 | 12.0 | 14.0 | 16.0 | 18.0 | 20.0 | 22.0 | 24.0 | 26.0 | 28.0 | 30.0 |

E.H.P. on current line, under E.M.F.

## COMPOSITION AND ELECTROMOTIVE FORCE OF BATTERY CELLS.

| Name. | Electrodes. | Solutions. | E.M.F. |
|---|---|---|---|
| Clark. | Pure mercury and pure zinc. | The mercury is covered with a paste of mercurous sulphate and a saturated solution of zinc sulphate, in which is placed the rod of zinc. | 1.434 at 15° C. at any temp $t$° C. it is 1.434[1 − .0008($t$° − 15°)]. |
| Daniell. | Copper and zinc. | The zinc is immersed in a solution of zinc sulphate, and the copper in a solution of copper sulphate. | Depends upon the densities of the solutions; it varies from 1.07 to 1.14 volts. |
| Groves. | Platinum and zinc. | The platinum is immersed in a strong nitric acid, and the zinc in dilute sulphuric acid. | About 1.93 volts. |
| Bunsen. | Carbon and zinc. | The carbon in nitric acid, and the zinc in dilute sulphuric acid. | About 1.74 volts. |
| Leclanche. | Carbon and zinc. | The carbon is packed in a porous pot with peroxide of manganese and broken gas carbon. The zinc is immersed in solution of sal ammoniac. | About 1.47 volts; but is quickly reduced if used to send a strong current. |
| Potash-bichromate. | Carbon and zinc. | The best solution is 1 lb. of potassium-bichromate, 2 lbs. strong sulphuric acid sp. gr. 1.836, and 12 lbs. water, in which both electrodes are immersed, the zinc being withdrawn when the cell is not in use. | About 2 volts; but is quickly reduced if employed to send a strong current. |

—Practical Engineers' Electrical Pocket Book.

## STANDARD TABLE OF HEIGHT AND WEIGHT.

| Height. | Weight. | | |
|---|---|---|---|
| | Maximum. | Standard. | Minimum. |
| 4 feet 10 inches | 150 | 105 | 83 |
| 4 " 11 " | 160 | 110 | 87 |
| 5 " | 167 | 115 | 92 |
| 5 " 1 " | 174 | 120 | 96 |
| 5 " 2 " | 181 | 125 | 100 |
| 5 " 3 " | 188 | 130 | 104 |
| 5 " 4 " | 195 | 135 | 108 |
| 5 " 5 " | 200 | 140 | 112 |
| 5 " 6 " | 205 | 145 | 115 |
| 5 " 7 " | 210 | 150 | 120 |
| 5 " 8 " | 215 | 155 | 125 |
| 5 " 9 " | 220 | 160 | 130 |
| 5 " 10 " | 225 | 165 | 135 |
| 5 " 11 " | 230 | 170 | 140 |
| 6 " | 235 | 175 | 145 |
| 6 " 1 " | 240 | 180 | 150 |
| 6 " 2 " | 245 | 185 | 155 |
| 6 " 3 " | 250 | 190 | 160 |
| 6 " 4 " | 255 | 195 | 165 |

—Table furnished by F. L. Hoffman, Insurance Statistician.

## THE AMERICAN EXPERIENCE TABLE OF MORTALITY.

| Age. | Expectation of Life in Years. | Number Dying in Each 1,000. | Age. | Expectation of Life in Years. | Number Dying in Each 1,000. |
|---|---|---|---|---|---|
| 20 | 42.20 | 7.81 | 60 | 14.10 | 26.69 |
| 21 | 41.53 | 7.86 | 61 | 13.47 | 28.88 |
| 22 | 40.85 | 7.91 | 62 | 12.86 | 31.29 |
| 23 | 40.17 | 7.96 | 63 | 12.26 | 33.94 |
| 24 | 39.49 | 8.01 | 64 | 11.67 | 36.87 |
| 25 | 38.81 | 8.07 | 65 | 11.10 | 40.13 |
| 26 | 38.12 | 8.13 | 66 | 10.54 | 43.71 |
| 27 | 37.43 | 8.20 | 67 | 10.00 | 47.65 |
| 28 | 36.73 | 8.26 | 68 | 9.47 | 52.00 |
| 29 | 36.03 | 8.35 | 69 | 8.97 | 56.76 |
| 30 | 35.33 | 8.43 | 70 | 8.48 | 61.99 |
| 31 | 34.63 | 8.51 | 71 | 8.00 | 67.67 |
| 32 | 33.92 | 8.61 | 72 | 7.55 | 73.73 |
| 33 | 33.21 | 8.72 | 73 | 7.11 | 80.18 |
| 34 | 32.50 | 8.83 | 74 | 6.68 | 87.03 |
| 35 | 31.78 | 8.95 | 75 | 6.27 | 94.37 |
| 36 | 31.07 | 9.09 | 76 | 5.88 | 102.31 |
| 37 | 30.35 | 9.23 | 77 | 5.49 | 111.06 |
| 38 | 29.62 | 9.41 | 78 | 5.11 | 120.83 |
| 39 | 28.90 | 9.59 | 79 | 4.74 | 131.73 |
| 40 | 28.18 | 9.79 | 80 | 4.39 | 144 47 |
| 41 | 27.45 | 10.01 | 81 | 4.05 | 158.61 |
| 42 | 26.72 | 10.25 | 82 | 3.71 | 174.30 |
| 43 | 26.00 | 10.52 | 83 | 3.39 | 191.56 |
| 44 | 25.27 | 10.83 | 84 | 3.08 | 211.36 |
| 45 | 24.54 | 11.16 | 85 | 2.77 | 235.55 |
| 46 | 23.81 | 11.56 | 86 | 2.47 | 265.68 |
| 47 | 23.08 | 12.00 | 87 | 2.18 | 303.02 |
| 48 | 22.36 | 12.51 | 88 | 1.91 | 346.69 |
| 49 | 21.63 | 13.11 | 89 | 1.66 | 395.86 |
| 50 | 20.91 | 13.78 | 90 | 1.42 | 454.55 |
| 51 | 20.20 | 14.54 | 91 | 1.19 | 532.47 |
| 52 | 19.49 | 15.39 | 92 | .98 | 634.26 |
| 53 | 18.79 | 16.33 | 93 | .80 | 734.18 |
| 54 | 18.09 | 17.40 | 94 | .64 | 857.14 |
| 55 | 17.40 | 18.57 | 95 | .50 | 1000.00 |
| 56 | 16.72 | 19.89 | | | |
| 57 | 16.05 | 21.34 | | | |
| 58 | 15.39 | 22.94 | | | |
| 59 | 14.74 | 24.72 | | | |

## THE AMOUNT OF ONE DOLLAR AT COMPOUND INTEREST.

| End of Year. | 3 Per Cent. | 3½ Per Cent. | 4 Per Cent. | 4½ Per Cent. | 5 Per Cent. | 6 Per Cent. | 7 Per Cent. |
|---|---|---|---|---|---|---|---|
| 1 | $1.03 | $1.04 | $1.04 | $1.05 | $1.05 | $1.06 | $1.07 |
| 2 | 1.06 | 1.07 | 1.08 | 1.09 | 1.10 | 1.12 | 1.14 |
| 3 | 1.09 | 1.11 | 1.12 | 1.14 | 1.16 | 1.19 | 1.23 |
| 4 | 1.13 | 1.15 | 1.17 | 1.19 | 1.22 | 1.26 | 1.31 |
| 5 | 1.16 | 1.19 | 1.22 | 1.25 | 1.28 | 1.34 | 1.40 |
| 6 | 1.19 | 1.23 | 1.27 | 1.30 | 1.34 | 1.42 | 1.50 |
| 7 | 1.23 | 1.27 | 1.32 | 1.36 | 1.41 | 1.50 | 1.61 |
| 8 | 1.27 | 1.32 | 1.37 | 1.42 | 1.48 | 1.59 | 1.72 |
| 9 | 1.30 | 1.36 | 1.42 | 1.49 | 1.55 | 1.69 | 1.84 |
| 10 | 1.34 | 1.41 | 1.48 | 1.55 | 1.63 | 1.79 | 1.97 |
| 11 | 1.38 | 1.46 | 1.54 | 1.62 | 1.71 | 1.90 | 2.10 |
| 12 | 1.43 | 1.51 | 1.60 | 1.70 | 1.80 | 2.01 | 2.25 |
| 13 | 1.47 | 1.56 | 1.67 | 1.77 | 1.89 | 2.13 | 2.41 |
| 14 | 1.51 | 1.62 | 1.73 | 1.85 | 1.98 | 2.26 | 2.58 |
| 15 | 1.56 | 1.68 | 1.80 | 1.94 | 2.08 | 2.40 | 2.76 |
| 16 | 1.60 | 1.73 | 1.87 | 2.02 | 2.18 | 2.54 | 2.95 |
| 17 | 1.65 | 1.79 | 1.95 | 2.11 | 2.29 | 2.69 | 3.16 |
| 18 | 1.70 | 1.86 | 2.03 | 2.21 | 2.41 | 2.85 | 3.38 |
| 19 | 1.75 | 1.92 | 2.11 | 2.31 | 2.53 | 3.03 | 3.62 |
| 20 | 1.81 | 1.99 | 2.19 | 2.41 | 2.65 | 3.21 | 3.87 |
| 21 | 1.86 | 2.06 | 2.28 | 2.52 | 2.79 | 3.40 | 4.14 |
| 22 | 1.92 | 2.13 | 2.37 | 2.63 | 2.93 | 3.60 | 4.43 |
| 23 | 1.97 | 2.21 | 2.46 | 2.75 | 3.07 | 3.82 | 4.74 |
| 24 | 2.03 | 2.28 | 2.56 | 2.88 | 3.23 | 4.05 | 5.07 |
| 25 | 2.09 | 2.36 | 2.67 | 3.01 | 3.39 | 4.29 | 5.43 |
| 26 | 2.16 | 2.45 | 2.77 | 3.14 | 3.56 | 4.55 | 5.81 |
| 27 | 2.22 | 2.53 | 2.88 | 3.28 | 3.73 | 4.82 | 6.21 |
| 28 | 2.29 | 2.62 | 3.00 | 3.43 | 3.92 | 5.11 | 6.65 |
| 29 | 2 36 | 2.71 | 3.12 | 3.58 | 4.12 | 5.42 | 7.11 |
| 30 | 2.43 | 2.81 | 3.24 | 3.75 | 4.32 | 5.74 | 7.61 |
| 31 | 2.50 | 2.91 | 3.37 | 3.91 | 4.54 | 6.09 | 8.15 |
| 32 | 2.58 | 3.01 | 3.51 | 4.09 | 4.76 | 6.45 | 8.72 |
| 33 | 2.65 | 3.11 | 3.65 | 4.27 | 5.00 | 6.84 | 9.33 |
| 34 | 2.73 | 3.22 | 3.79 | 4.47 | 5.25 | 7.25 | 9.98 |
| 35 | 2.81 | 3.33 | 3.95 | 4.67 | 5.52 | 7.69 | 10.68 |
| 36 | 2.90 | 3.45 | 4.10 | 4.88 | 5.79 | 8.15 | 11.42 |
| 37 | 2.99 | 3.57 | 4.27 | 5.10 | 6.08 | 8.64 | 12.22 |
| 38 | 3.07 | 3.70 | 4.44 | 5.33 | 6.39 | 9.15 | 13.08 |
| 39 | 3.17 | 3.83 | 4.62 | 5.57 | 6.70 | 9.70 | 13.99 |
| 40 | 3.26 | 3.96 | 4.80 | 5.82 | 7.04 | 10.29 | 14.97 |
| 41 | 3.36 | 4.10 | 4.99 | 6.08 | 7.39 | 10.90 | 16.02 |
| 42 | 3.46 | 4.24 | 5.19 | 6.35 | 7.76 | 11.56 | 17.14 |
| 43 | 3.56 | 4.39 | 5.40 | 6.64 | 8.15 | 12.25 | 18.34 |
| 44 | 3.67 | 4.54 | 5.62 | 6.94 | 8.56 | 12.99 | 19.63 |
| 45 | 3.78 | 4.70 | 5.84 | 7.25 | 8.99 | 13.76 | 21.00 |
| 46 | 3.90 | 4.87 | 6.07 | 7.57 | 9.43 | 14.59 | 22.47 |
| 47 | 4.01 | 5.04 | 6.32 | 7.92 | 9.91 | 15.47 | 24.05 |
| 48 | 4.13 | 5.21 | 6.57 | 8.27 | 10.40 | 16.39 | 25.73 |
| 49 | 4.26 | 5.40 | 6.83 | 8.64 | 10.92 | 17.38 | 27.53 |
| 50 | 4.38 | 5.58 | 7.11 | 9.03 | 11.47 | 18.42 | 29.46 |

## ROMAN NOTATION.

1 = I.
2 = II.
3 = III.
4 = IV.
5 = V.
6 = VI.
7 = VII.
8 = VIII.
9 = IX.
10 = X.
20 = XX.
30 = XXX.
40 = XL.
50 = L.
60 = LX.
70 = LXX.
80 = LXXX.
90 = XC.
100 = C
500 = D, or LↃ.
1,000 = M, or CↃ.
2,000 = MM, or IIↃↃↃ.
5,000 = V, or LↃↃ.
6,000 = VI, or MMM.
10,000 = $\overline{X}$, or CↃↃ.
50,000 = $\overline{L}$, or LↃↃↃ.
60,000 = $\overline{LX}$, or MMMↃ.
100,000 = $\overline{C}$, or CↃↃↃ.
1,000,000 = $\overline{M}$, or CↃↃↃↃ.
2,000,000 = $\overline{MM}$, or MMↃↃↃ.

A line over a number increases it 1,000 times.

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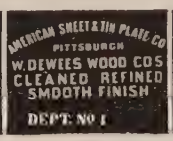

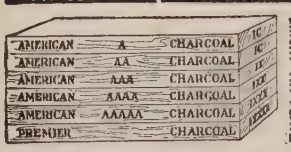

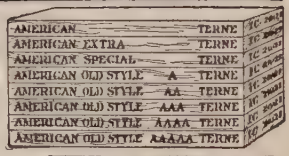
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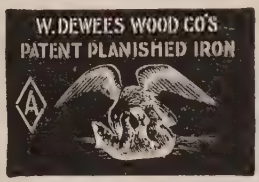

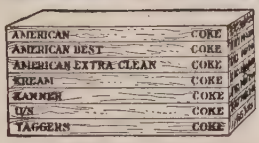

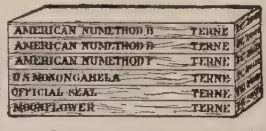


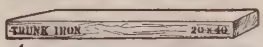


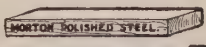

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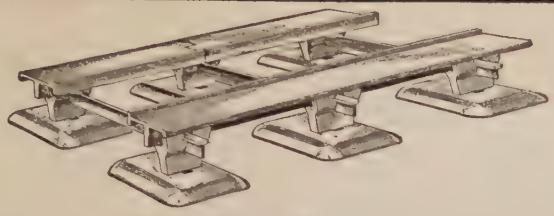

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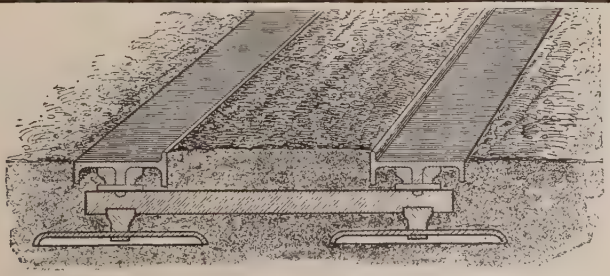

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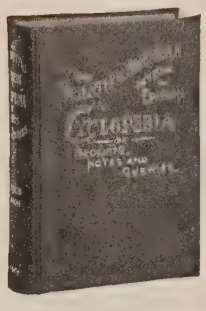

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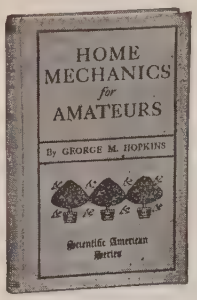


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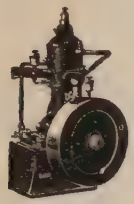

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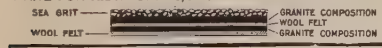


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